THE Petroleum Engineer

JULY 1936

VOLUME VII NUMBER XI

A MAGAZINE OF METHODS FOR OPERATING MEN

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American Petroleum Institute, 17th Annual Meeting — November 9, 10, 11, and 12, Stevens Hotel, Chicago, Illinois.

•

Independent Petroleum Association of America, Annual Meeting—November 30-December 1, Baltimore Hotel, Oklahoma City, Oklahoma.

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The Course of Oil

By K. C. SCLATER

Valuable Data Published

One of the most valuable contributions yet made to the technical literature on natural gas has recently been published by the U. S. Bureau of Mines. It is designated as Monograph 7 and carries the title "Back-Pressure Data on Natural-Gas Wells and Their Application to Production Practices." In this Monograph are published the results of perhaps the most comprehensive and authoritative study ever undertaken of the subject with which it deals. It represents the fruits of several years' exhaustive investigation.

According to the authors it supplements information published in a previous report and covers in detail recommended procedure for obtaining data and analyzing results that are more practical and easier to use. In addition, it includes an analysis of the application of back-pressure data to gas-production problems.

Much of the information can be applied to oil production practice, hence it at once becomes a valuable reference for the petroleum engineer.

The State of Oklahoma and the Natural-Gas Department of the American Gas Association cooperated in the experimental work on which the report is based. E. L. Rawlins and M. A. Schellhardt, the authors, merit the thanks of the many technical men in the industry who may have occasion to refer to the report and use the data therein.

Proration and Energy Conservation

Proration has evolved into energy conservation and hence has come to stay in the industry. "With or without organized proration no new field will ever again, in my opinion, be produced without regard to the intelligent use of the reservoir energy inherent therein. Restricting flush production originally for the purpose of stabilization proved to be the greatest step toward true conservation ever undertaken." Such was the opinion expressed by John M. Lovejoy, President of the American Institute of Mining and Metallurgical Engineers, in a recent address delivered at a meeting of the Independent Petroleum Association of America. He went on to say, "As engineers and operators, I think we should encourage legislation in every oil state prohibiting the waste of the reservoir energy of oil fields, purely and entirely as a conservation measure. This energy is a force which when prematurely exhausted or if used for inferior purposes causes a loss to the state of incalculable value and is forever irrecoverable."

Proration, when looked at in the light of energy conservation, has proved to be the most beneficial practice ever followed by the oil industry. Besides stabilizing the industry, it has contributed more than any other one factor toward reducing lifting costs and increasing the efficiency of oil recovery.

Maintaining Reservoir Pressure

Drilling in the East Texas field continues at a pace that might be termed brisk considering the fact that proration has reduced the average allowable per well almost to the marginal point of twenty barrels daily. With more than 23,000 wells in the field and continued drilling, it is inevitable that the allowable per well must be reduced still more. Increase of the field allowable is unlikely, and would be very unwise, for there is ample justification for holding it to what it is at present.

Regulation of production in the field on the whole has been strict but there is evidence that irregularities still exist. One of the most widespread of these is the practice of obtaining allowables for wells that are "dead" by failing to report them; such allowable production is drawn exclusively from the best or most active wells on the lease. An operator who resorts to this practice is thus enabled to obtain a larger allowable than he is really entitled to under the regulations. This, of course, aggravates the present situation of the operator with good active wells, because he is handicapped in obtaining a higher allowable by such misdemeanors on the part of the unscrupulous element in the field.

A larger drop in bottom-hole pressure than usual last month also appeared as a disturbing factor. It is estimated that 27,000 barrels of water is being produced daily in the East Texas field, and it is surmised that this large volume of water production is having its effect on bottom-hole pressures. It is obvious that if wells are allowed to produce water in unrestricted quantity a serious reduction in reservoir pressure is bound to result. Something will have to be done, and done quickly, to conserve the reservoir energy for the production of oil—and not water. If this condition is allowed to get out of hand it may mean that the flowing life of all wells in the field will be brought to an abrupt end; artificial methods of lifting the oil then will have to be resorted to. Apparently the matter of prorating the amount of water to be produced by each well is under consideration by engineers of the Railroad Commission in an effort to guard against too great a drop in reservoir pressure. By maintaining a reasonable rate of decline of bottom-hole pressure, energy will be conserved and the life of flowing wells increased. Efforts of Railroad Commission engineers toward this end should have the whole-hearted support of every operator in the East Texas field.

« « « HIGHLIGHTS IN OILDOM » » »

Search For Oil in Chile

After four years of inactivity the Department of Mines and Petroleum has renewed its search for oil in the extreme northern territory of Magallanes, Chile. The work is to be conducted over a period of years provided the government appropriates sufficient funds. Three million pesos (approximately $115,000) has been alloted for the current calendar year. Notwithstanding the small sum at the disposal of the government for 1936, the personnel in Magallanes is active on the following: 1. Drilling will be continued at Punta Prat to a depth of 1800 meters as compared with 1300 meters in 1932. 2. New drilling activity will be started at Tres Puentes. 3. A renewed study will be made of the test known as R-2, where oil appeared. 4. A well will be drilled in the region of Chabunco to a depth of 600 meters. 5. The schedule for 1936 includes the numerous drilling operations on a ranch known as Pocket and at other points in the vicinity of Tres Puentes.

•

Tenders Given Rodessa Oil Products

A district court at Austin, Texas, has authorized intrastate movement of 55,000 bbl. of oil products manufactured from Rodessa, Louisiana, crude that previously had been banned in interstate commerce movement by a federal court order. The products, owned by the East Texas Refining Company of Dallas, represented part of the crude produced by the Pelican Oil and Gasoline Company under a special order of the Louisiana Conservation Commission that permitted the company to produce 20,000 bbl. daily from its Sexton lease in the Rodessa field.

Judge W. F. Robertson held that the state had not shown the oil to be illegal, refusing admittance of federal court findings upon which the state depended solely in opposing the suit brought by the East Texas Refining Company.

The suit raised issues novel to Texas oil litigation. The district court ruling had the effect of setting a precedent that the taint of a federal decree holding crude contraband did not extend to intrastate movement of it. In addition, the actual products involved had been twice substituted for the original crude produced by the Pelican Oil and Gasoline Company.

•

Consider Water Proration in East Texas

Prorating water production as a means of maintaining bottom-hole pressure in the East Texas field is being considered, according to a statement made recently by C. V. Cottingham, chief petroleum engineer for the Texas Railroad Commission. Cottingham said that either proration or requiring that water be returned to the sand has been under consideration for some time but no official action has been taken.

"I believe the estimate is that approximately 27,000 bbl. of water are being produced daily in the East Texas field. That is where our pressure is going," he said. The Railroad Commission is facing a very difficult problem of conserving pressure, according to Cottingham.

Discuss New Way Taking Potentials

Operators of the Fitts pool of Pontotoc County, Oklahoma, are concerned with perfecting a new method of taking potentials of completed wells. On July 8 a meeting was held in Tulsa at which time recommendations were made by the engineering committee of the Fitts operators' group. The outlined tentative plan calls for arriving at new potentials on the basis of initial production and the cumulative output since the well came in. The proposal will be studied by the operators and another meeting held July 22, at which time it will be decided whether the plan is acceptable, or whether another proposal shall be considered.

•

Elk Hills Crude Price Advanced

An advance of from 5 cents to 34 cents per bbl. for crude oil in the Elk Hills field of California was posted recently by the Standard Oil Company of California. The action was taken after the Central Committee of California Oil Producers had certified that production for the field had been reduced to the allotment established by the committee. Previously the Standard had made similar price advances in 25 fields throughout the state. Except for Alamitos Heights, Dominguez, and the Lakeview area of Midway-Sunset the advances are now in effect in all fields where the company purchases crude oil.

•

Crude Prices Up in Michigan

The Simrall Pipe Line Corporation and the Pure Transportation Company, major carriers in the state of Michigan, as well as smaller purchasers, have increased their posted price for Michigan crude ten cents a barrel. The price posted for Porter, Greendale, Leaton, Crystal, and similar grade crude is $1.42 per bbl., and for Ogemaw and similar grades, $1.26 a barrel.

The advance in crude quotations is said to be due to the inequality of Michigan crude production and refinery demand. Independent refineries in the state have a total capacity of 40,000 bbl. daily, and, in addition, approximately 25,000 bbl. is being moved daily to Toledo, Ohio.

•

Gas-Oil Survey For Texas Fields

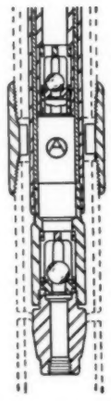
The Texas Railroad Commission has ordered that gas-oil ratio surveys be made in West Texas, West Central Texas, and the Gulf Coast area. Operators in these districts must file with the commission a report of production during July and August, indicating the ratio of each well.

•

Renewed Drilling in Holstein, Germany

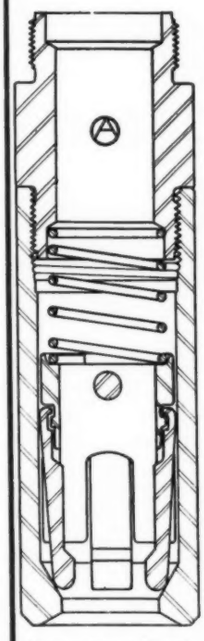
Since the Deutsche Petroleum Aktiengesellschaft started drilling in April, 1935, with a government subsidy on a location south of Heide, in Holstein, Germany, four wells have been successfully completed, marking the first activity in that area subsequent to 1926. The four wells produce an average of ten metric tons each per day.

The first oil was struck in September, 1935, two more wells were brought in in January, 1936, and the fourth successful test was during April of this year. The latter well was completed at a total depth of 450 meters and initially yielded approximately 20 tons of crude oil daily.



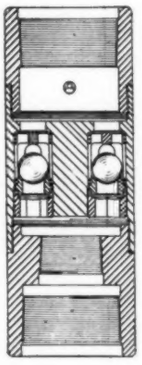
Combined Collar and Cage

Secures maximum fluid from working stroke with Rod Sectional Liner Stationary Pumps equipped with Perry Plungers. Plunger travels closer to working valve and closes space where gas might trap.



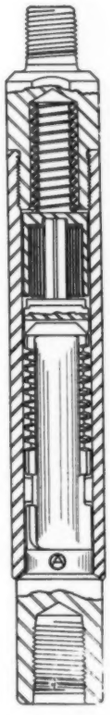
Heavy Duty Standing Valve Puller

Allows traveling unit to be set down on the pin any number of times without injury to either member. Connects only when rods are rotated to the right after setting down on standing valve, giving positive control of puller.



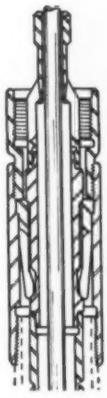
Multiple Standing Valve

Replaces regular standing valve of Tubing Sectional Liner Pump. Gives larger fluid capacity, less ball lift, faster valve action, and by dividing the load onto several valves, reduces the load per valve. Permits positive comparison of seat and ball life of different designs or metals.



On-or-Off Attachment

Permits connection or disconnection of sucker rods at the pump. Insures against stripping jobs in any installation. Guide coupling should be used both above and below this unit in the rod string.

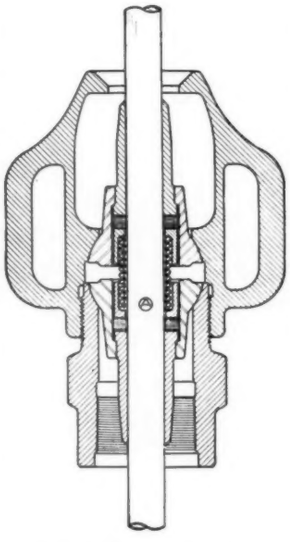


Top-Lock Hold-Down

Allows stationary type rod pump to be completely suspended from its upper end and prevents sand packing between pump and tubing. Gives positive anchorage and easy removal of pump.

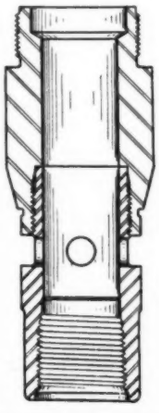
Anchor Hold-down Bodies

New 3-piece construction gives increased service life with ease of reconditoning. Requires no change in the shoe. Affords choice of metals in seating ring.



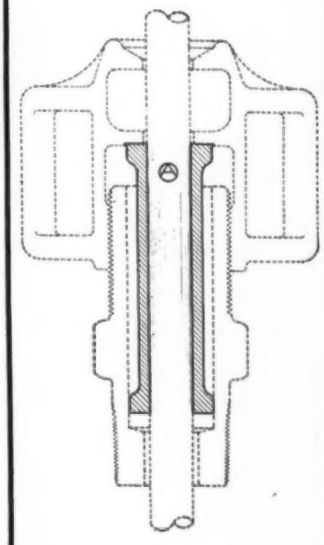
Self-aligning Stuffing Box

Metal-to-metal seal. Accurately fits polished rod. Ball joint on followers makes the box 100% self-aligning. Grease fitting permits lubrication of polished rod and ball joint. No grease leakage.



Ritter Standing Valve Body

Makes reconditioning easier and lengthens service life. Simplifies assembly and removal of the lock ring and prevents damage to ring. Facilitates grinding of the body into the shoe.



Frahm Stuffing Box Follower

Seals around the polished rod for long periods of time without leaking and seals without repacking or adjusting. Will not burn for lack of lubrication if the well pumps off. Removes fire hazard.

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OIL WELL PUMPS **AXELSON** **SUCKER RODS**

LATEST ACTIVITIES IN THE OIL FIELDS

A NEW pool has been discovered in Hopkins County, Northeast Texas. After drilling their No. 1 Worsham to a depth of 4500 ft., Hager, Luse and Russ obtained a good showing of oil, which is of heavy gravity, about 24 corrected. The well is near the town of Sulphur Bluff, and approximately 16 miles from the Talco field. The discovery is along the Mexia-Talco fault trend.

●

Several strikes have been made in Kansas within recent weeks, the latest being the finding of a new pool in Rice County, and the successful completion of a number of wildcats. No. 1 Bowman of the Simpson and Noble Drilling Company and the Stanolind Oil and Gas Company, in Rice County, drilled to a depth of 3294 ft. in the Siliceous lime, initially swabbed 89 bbl. of oil in 16 hours. After deepening to 3305 ft. the well was acidized and swabbed 185 bbl. in four hours. The wildcat strikes were Lloyd, Frost and Study's No. 2 McKinley in Cowley County, an extension to the Churchill pool; No. 1 Beyers of F. Jones, G. W. Hinkle, et al, which opened a new pool one mile south of the Breford pool on the Ellsworth-Barton county line; and Phillips Petroleum Company's No. 1 Kaufman, three miles south of Moundridge in Harvey County.

●

The Texas Company's test No. 2 Eureka, 220 miles north of San Francisco, blew out a few days ago after being drilled to 4428 ft., and at latest reports circulation had not been recovered. The test is the most northerly in the state of California and should it be completed as a commercial oil or gas well it would prove of great importance because of the isolation of the area and the inadequate supply of oil and gas.

●

A new producing area has been opened in southeast Lincoln County, Oklahoma, by the Amerada Petroleum Corporation and the Stanolind Oil and Gas Company with their No. 1 Zimmerman. Production is from the Hunton lime at a total depth of 4358 feet. After being acidized the well flowed and swabbed 80 bbl. of oil in 17 hours. Nearest production is six miles to the north.

●

Another new pool for Oklahoma has been discovered by W. H. Riddle and Associates in Carter County with their No. 1 Tussy. The well is three miles north of the Scholem Alachem pool, and found production at 2918 ft. and 3023 ft. after plugging back from 3402 feet. Initially it made an estimated production of 80 bbl. of oil per day.

●

Sundance production in the Lance Creek field of eastern Wyoming has been extended one mile to the east. Continental Oil Company's No. 3 Apex Account 2, drilled to a total depth of 4026 ft., produced 25 bbl. through the drill stem in a period of one-half hour.

●

Activity continues at a rapid pace in the Corpus Christi area of Texas. One of the recent interesting discoveries is that of M. F. Hurlburt nine and a half miles southeast of Corpus Christi in Nueces County. That operator's No. 1 Phillips was drilled to a depth of 7503 ft., plugged back to 6657 ft., and casing set and perforated. At latest reports it gauged 23 bbl. of pipe line oil hourly through a ¼-in. choke, with 500 lb. pressure on the tubing and 800 lb. on the casing.

●

The Texas Company and the C. & G. Oil Company's No. 1 Ellen Weir, three miles east of the Monument field of New Mexico, has been completed as a commercial producer. Drilled to a total depth of 4075 ft., and treated with acid, the well swabbed and flowed at the rate of eight bbl. of oil per hour. Production is from a lime formation.

AVERAGE CRUDE PRICES

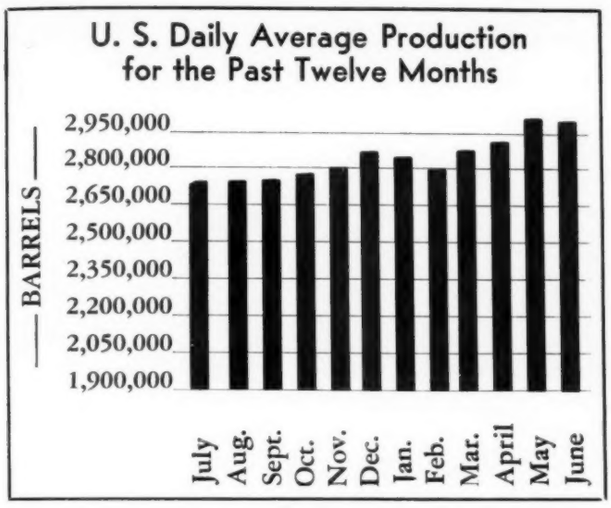
California		Louisiana	
Kettleman Hills	$1.22-1.43	Gulf Coast	$ .82-1.22
Playa Del Rey	1.10	North Louisiana	.86-1.10
Coalinga	.70-.90	Illinois	1.23
Signal Hill	1.10	Kentucky	1.23
Montana	1.45	Indiana	1.12
Wyoming	1.10	Ohio	
Colorado	1.00-1.10	Lima	1.25
New Mexico	.75-.95	Michigan	1.12
Texas		Pennsylvania	
North Central	.84-1.08	Bradford	2.45
Panhandle	.81-.98	Southwest	2.17
West Texas	.75-.95	Eureka	2.12
Gulf Coast	.85-1.30	Buckeye	1.97
Darst Creek	.88-1.22	Corning	1.42
East Texas	1.15	West Virginia	1.67
Kansas	1.10	Canada	2.10-2.17
Oklahoma	1.10		
Arkansas	75.-.80		

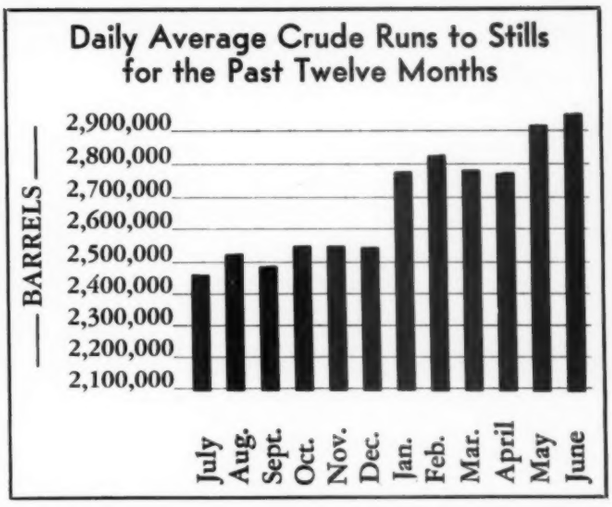
DAILY CRUDE OIL PRODUCTION

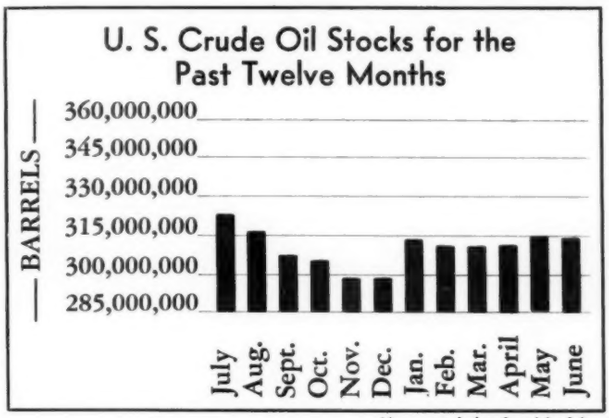
Data Supplied by A. P. I.

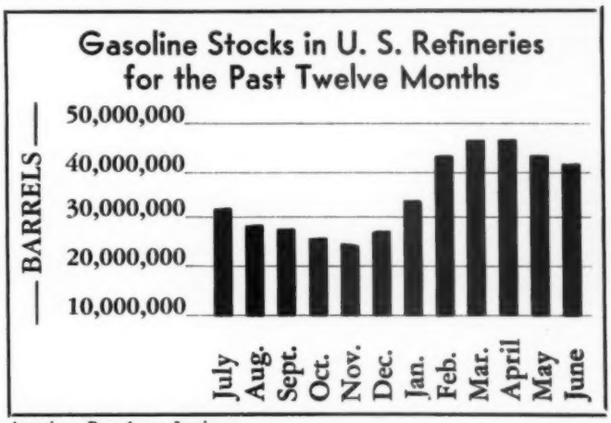
(Figures in Barrels)

	B. of M. Dept. of Interior Calculations (June)	Week Ended June 27 1936	Week Ended May 30 1936	Week Ended June 29 1935
Oklahoma	552,500	555,300	531,600	521,200
Kansas	153,100	146,000	155,300	147,500
Panhandle Texas	.....	65,250	62,450	58,700
North Texas	.....	59,000	58,850	59,250
West Central Texas	.....	25,300	25,450	25,450
West Texas	.....	180,950	177,700	153,900
East Central Texas	.....	53,700	51,850	50,000
East Texas	.....	440,100	435,650	466,900
Southwest Texas	.....	86,250	81,950	64,450
Coastal Texas	.....	254,600	251,850	186,250
TOTAL TEXAS	1,125,700	1,185,150	1,145,750	1,064,900
North Louisiana	.....	76,350	84,600	22,650
Coastal Louisiana	.....	146,400	148,650	118,550
TOTAL LOUISIANA	175,700	222,750	233,250	141,200
Arkansas	31,800	29,650	29,850	30,950
Eastern	103,200	110,100	114,600	107,700
Michigan	37,000	36,850	32,950	42,950
Wyoming	37,800	36,900	36,150	38,400
Montana	13,000	16,950	17,050	10,100
Colorado	4,700	5,200	4,600	4,050
New Mexico	68,300	73,100	74,850	52,900
TOTAL EAST OF CALIF.	2,302,800	2,397,950	2,375,950	2,161,850
California	535,500	571,200	568,000	528,000
TOTAL U. S.	2,838,300	2,969,150	2,943,950	2,689,850









Above statistics furnished by the American Petroleum Institute.

Summarized Operations in Active Fields for June, 1936

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	291	275	71	95	3600	2	40	Rotary
Duval County	138	121	37	59	2300	2	22	Rotary
Archer County	44	18	21	45	660–1800	1 or 2	40	Rot.-Cab.
Conroe	5	4	1	4	2000–7400	3 or 4	40	Rotary
Panhandle	58	56	44	172	2200–3000	2	40	Rotary
Refugio County	12	12	4	12	5200	2	38	Rotary
Oklahoma								
Oklahoma County	84	62	18	53	6500	3	39	Rotary
Pontotoc County	50	42	42	173	1800–4488	2 or 3	38	Rotary
Osage County	37	30	12	41	380–2850	2	37.5–40	Rot.-Cab.
Kansas								
McPherson County	5	5	2	5	2900–4300	2	38	Rot.-Cab.
Harvey County	0	0	1	2	3450	2 or 4	37	Rot.-Cab.
Ellsworth Arch	119	92	44	143	3300	4	37	Rot.-Cab.
Louisiana								
Rodessa	34	34	15	56	5985–6450	3	39	Rotary
California								
Kettleman Hills	4	4	7	30	8300	3 or 4	40	Rotary
Long Beach	0	0	2	7	7000	3	36	Rotary

Field Activities by States for June, 1936

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1935 (In Barrels)
	June	May	June	May	June	May	June	May	June	May	
Arkansas	9	7	2	1	5	21	12	13	38	41	11,140,750
California	104	61	92	56	89	133	90	104	260	288	207,899,480
Colorado	2	....	2	....	....	....	4	5	28	29	1,565,150
Illinois	14	....	10	....	....	....	16	22	14	8	4,352,000
Indiana	13	9	11	4	....	....	5	6	72	71	762,000
Kansas	177	173	137	122	121	210	57	67	308	356	53,013,450
Kentucky	14	54	13	29	....	....	7	8	17	19	4,860,000
Louisiana	109	131	81	106	93	133	67	70	226	238	50,299,950
Michigan	91	81	64	59	65	96	80	85	122	131	15,661,350
Mississippi	3	1	0	0	....	....	1	1	8	9	Gas. Prod.
Montana	21	16	19	15	....	....	12	13	68	67	4,304,100
New Mexico	69	65	63	59	....	....	22	21	121	123	19,195,500
New York	....	....	....	....	....	....	1	1	2	2	3,191,900
Ohio	117	169	85	131	....	....	44	46	180	184	4,234,000
Oklahoma	364	267	268	197	215	325	75	92	618	744	181,152,050
Pennsylvania	....	....	....	....	....	....	11	13	110	119	14,478,000
Texas	1266	1355	978	1048	1414	1694	710	673	2036	1925	377,747,205
West Virginia	64	67	50	58	....	....	38	39	134	136	3,818,400
Wyoming	8	4	7	0	....	....	16	15	83	81	13,390,100
Totals	2431	2460	1872	1885	2002	2575	1273	1294	4440	4571	970,995,385

PROGRESS OF MAJOR PIPE LINE WORK

THE Stanolind Pipe Line Company is laying a 40-mile 8-in. pipe line to serve the fields of Nowata County, Oklahoma. Increased production in the area, resulting from water-flooding operations, has made the additional transportation facilities necessary.

The line will be of all-welded construction and will extend from the Alluwe station to the Blake station of the company. No additions or changes will be made in the set-up of the Alluwe station. It will be used to pump into the 8-in. line oil gathered from leases in the vicinity by a system already in existence. When flush production is reached portable pumps will be used in addition for pumping into the 8-in. line and on to the Blake station. The portable pumps will be powered by electric motors or internal combustion engines.

O. C. Whitaker, Inc., Burkburnett, Texas, has the contract for the job, and the pipe used has been reclaimed from portions of the Stanolind Pipe Line Company's system no longer in use in Illinois and Missouri, with some coming from Oklahoma.

The line will have a capacity in excess of 12,000 bbl. daily, and is expected to be in operation by August 1st.

●

Lindgren and Swinerton, Inc., Los Angeles, California, have been awarded the general contract for laying a pipe line for the Shell Oil Company between Bakersfield and Martinez, California. It will be constructed of 8-in., 10-in., and 12-in. pipe. H. C. Price, Inc., of Bartlesville, Oklahoma, has been given a contract for electric-welding the line.

●

Work is progressing on the Texas-Empire Pipe Line Company's construction program for improving crude oil transportation facilities between western Kansas and central Illinois. The Oklahoma Contracting Company, Dallas, Texas, is laying 48 miles of the 8-in., from Valley Center to Pittsburg, Kansas, using the Lindeweld method of oxy-acetylene welding. Kelley-Dempsey and Company, Tulsa, Oklahoma, are laying a 24-mile 12-in. loop on the main line near Lowry City, Missouri. Williams Brothers Construction Company, Tulsa, is laying two 12-in. loops, totaling 38 miles, in Illinois, at the eastern end of the project. These loops also are being Lindewelded. Other contractors are Truman-Smith Construction Company, El Dorado, Kansas, who are laying the extreme east and extreme west links, as well as two loops; and Jones and Brooks, Inc., Oklahoma City, Oklahoma, who have been given the contract for two of the loops.

The 10-in. line from Valley Center, Kansas, provides a direct route for western Kansas crude oil to Illinois refineries by connecting to the Texas-Empire main line extending from Oklahoma across Missouri to points in Illinois. The loops to the main system are to assist in handling the increased load from the 10-in. line.

Williams Brothers Construction Company, Tulsa, Oklahoma, has been awarded the contract for laying the 178-mile gasoline line between Augusta, Kansas, and Kansas City, Missouri, for the White Eagle Division of the Socony-Vacuum Oil Company. The 6-in. line will be welded by the oxy-acetylene method. Construction work already has started.

White Eagle officials announce that a total of $1,500,000 will be expended on the project, $300,000 of which will go for the construction of a terminal at Kansas City on the west bank of the Missouri River. A smaller terminal will be built at Topeka, Kansas.

●

The Stanolind Pipe Line Company has announced a new 6-in. line to serve the producing areas of northern Ellis and southern Rooks counties, Kansas. The line will connect with an existing line of the Stanolind in northwestern Russell County and extend to the Bemis area in Ellis County, and likely to the Zurich district in Rooks County. The Stanolind already has a 4-in. line serving the Shutts and Bemis areas of Ellis County, but constantly increasing production in Ellis and Rooks counties makes the larger line desirable.

●

The Texas Pipe Line Company has awarded a contract to the White Deere Pipe Line Construction Company of Oklahoma City, Oklahoma, for the construction of a 6-in. gas line in the North Texas area. The line will be approximately 30 miles in length, extending from the Johnson field in western Foard County to Quanah. It will be welded, using the Lindeweld method of oxy-acetylene welding.

●

According to reports the Humble Pipe Line Company plans to lay a pipe line from the Talco field of Texas to its booster station in the East Texas field, near Longview, a distance of approximately 63 miles. It likely would be a 10-in. line. While no definite statement has been made as to when construction work will commence, the right-of-way is being surveyed, and the Humble Oil and Refining Company has erected two 55,000-bbl. tanks in the Talco field in which to store crude oil pending the completion of the outlet.

●

The pipe line of the East Texas Pipe Line Company extending from the Rodessa field of Louisiana to the East Texas field, a distance of 59 miles, has been sold to the United Gas Company. The papers, which were filed at Marshall, Texas, conveyed the property to W. F. Hartwig, assistant to the general superintendent of the United Gas Company at Houston. The consideration involved was not stated. The property conveyed included the pipe line, pumping stations, gathering lines at Rodessa, rights-of-way, and other assets.

. . . with Multi-Flame Lindewelding

Multi-Flame Lindewelding on a 143-mile 8 in. pipe line. Shown on the gas wagon with the cylinders of Linde Oxygen is an Oxweld Type MP-4 Acetylene Generator.

The three flames of the Multi-Flame Lindewelding Head improve the metallurgy of welds. The small flames preheat, while the large flame welds and post-heats.

you can make Strong, Ductile Welds

Multi-flame Lindewelding, when done properly, produces welds that are as strong as the pipe base material, even when the tensile strength is 110,000 lb. per sq. in. In Lindewelding a minimum of base metal is melted into the puddle. Thus both the efficiency of welding and the uniformity and quality of the weld metal are increased.

By the use of the multi-flame the base metal is preheated before welding and post-heated for slower cooling after welding. This exclusive feature of Multi-Flame Lindewelding makes the weld unusually ductile.

Multi-Flame Lindewelding is fast and economical even under the varied conditions that exist in the field. It saves 15 to 40 per cent in oxygen, acetylene and welding rod consumed, and often as much as 50 per cent in time required to make welds.

The Multi-Flame Lindewelding process is a result of the closely coordinated laboratory, development and field engineering facilities of the Linde organization. It reflects the vast welding experience achieved through the application of Linde Process Service on more than 20,000 miles of pipe lines. Why not have Linde work with your engineers on their next pipe line project? This help is available from a Linde Office near you. Write or phone for complete information. The Linde Air Products Company—Unit of Union Carbide and Carbon Corporation—New York and Principal Cities.

Everything for Oxy-Acetylene Welding and Cutting

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES

FROM PRODUCTS OF UNITS OF UCC UNION CARBIDE AND CARBON CORPORATION LINDE UNION CARBIDE

THE MONTH'S ACTIVITIES IN REFINING

Percent Refinery Capacity Operated

Western Division, 72.2 per cent **Central Division, 72.0 percent** **Eastern Division, 84.5 per cent**

PETROLEUM ENGINEERING, Inc., Tulsa, Oklahoma, associated with Arthur G. McKee and Company, Cleveland, Ohio, has obtained a contract from the Amtorg Trading Corporation for the construction of a combination crude oil stabilizing plant and a gasoline absorption plant. The equipment is to be manufactured in the United States and the plant erected in the Bibi-Ebat field near the city of Baku, Russia.

The plant will have a capacity for processing 35,000 bbl. of crude oil daily and 25,000,000 cu. ft. of gas at 350 lb. pressure. It will produce stable crude, natural gasoline, and pure butane and propane.

Petroleum Engineering, Inc., will supply complete equipment for the plant and a supervising engineer for construction and operation of the unit. All labor will be provided by the Soviet Government.

●

The Rado Refinery at McAllen, Texas, is being enlarged and its capacity will be doubled by October 1st, it is announced by Charles J. Holland, new president and general manager of the company, who has been in charge of the plant for more than a year. The plant processes crude from the Hidalgo and Starr County fields. Other officers, in addition to Holland, are: Ralph E. Fair, Dallas, vice-president; J. L. Dobdell, Dallas, secretary-treasurer; J. Franklin Ewers, Mission, assistant secretary-treasurer.

●

The absorption-type gasoline plant under construction in the Rodessa field in Louisiana by the Glenrose Gasoline Company is nearing completion. It will be in operation by August 1st. The plant has a daily capacity of 15,000,000 cu. ft. of gas with a 60 percent overload.

●

The Phillips Petroleum Company has announced details for the installation of four new polymerization units.

The program, now under way, includes the construction of four new units having an aggregate capacity of 3500 bbl. of polymerized gasoline per day. Three of these will be at Borger, Texas, each having a capacity of 1000 bbl. per day, bringing the total polymerized gasoline capacity there to 4000 bbl. daily. One of the three has been completed and is now in operation. The fourth unit, which will be at Kansas City, is almost completed, and will have a polymerized gasoline capacity of 500 bbl. per day. Gasoline produced will have a blending value of 85 octane number and above.

While the Kansas City installation will serve mainly for the polymerization of refinery gases, the new units at Borger will be used almost exclusively for the polymerization of natural gas.

●

Construction of a polymerization unit at East Chicago has been completed by the Sinclair Refining Company. It is of the catalytic type and will operate on cracked gases.

●

A 500-bbl. skimming plant is being erected at Stamford, Jones County, Texas, by W. H. Peckham of Wichita Falls. It will operate on crude trucked from the Lueders and Hawley pools.

●

The capacity of the Sinclair Refining Company's plant at Marcus Hook, Pennsylvania, has been increased from 30,000 bbl. to 35,000 bbl. of crude daily with the addition of new fractionating towers and vapor and liquid heat exchangers. A modern dock, approximately 1000 ft. long, also is being constructed, on the Delaware River.

●

The Old Dutch Refining Company, Muskegon, Michigan, will add a unit for the manufacture of lubricating oil stocks. The work will start about August 15, at which time the vapor-phase cracking unit now being installed will be completed.

●

The Texas Company has announced it is installing new equipment in its refinery at Paducah, Texas, which, when completed, will increase the capacity of the plant from 5000 bbl. to 10,000 bbl. daily.

●

The Gulf Oil Corporation has completed an absorption-type natural gasoline plant in Ward County, Texas, having a 25,000,000 cu. ft. daily capacity. It is a 10-unit plant and is connected to approximately 120 wells.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks
Week Ended June 27, 1936
A.P.I. Figures
(Figures in Barrels of 42 Gallons Each)

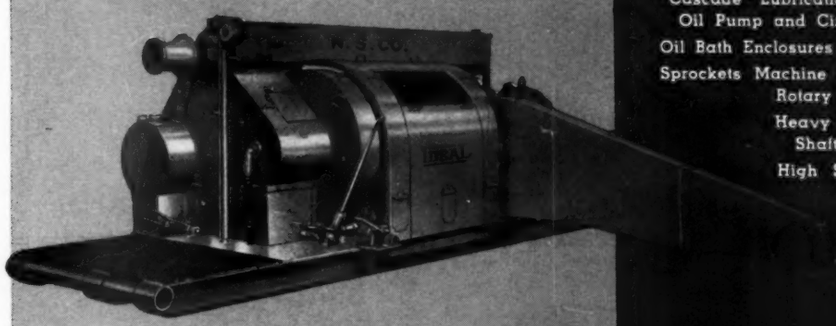
DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	534,000	87.3	19,273	9,677
Appalachian	94.8	108,000	74.0	2,554	462
Ind., Ill., Ky.	96.1	409,000	92.1	9,597	4,131
Okla., Kans., Mo.	84.8	292,000	76.0	6,815	3,382
Inland Texas	48.5	104,000	65.0	1,429	1,863
Texas Gulf	96.8	562,000	85.4	7,555	7,752
La. Gulf	96.4	118,000	72.4	1,462	2,024
No. La.-Ark.	90.0	44,000	61.1	418	409
Rocky Mt.	61.9	47,000	78.3	1,377	771
California	92.6	522,000	66.2	13,229	71,873
Reported	89.7	2,740,000	78.6	63,709	102,344
Est'd. Unreported		190,000		4,732	2,941
*EST'D. TOTAL U. S. June 27, '36		2,930,000		68,441	105,285
*EST'D. TOTAL U. S. June 20, '36		2,950,000		69,214	104,728
U. S. B. of M. June, 1935		2,724,000		**59,507	**103,647

*Bureau of Mines basis currently estimated.
**As of June 30, 1935.

IDEAL
"Reg. U. S. Pat. Off."

DRAW WORKS

NO. 23-9-FE



A 1000 Horsepower Draw Works that sets a new standard of safety, speed, and economy in a heavy draw works for drilling of the deepest wells. In addition to being entirely self-contained, its other important advantages include:

"Cascade" Lubrication of all Chains and Sprockets through Oil Pump and Circulation System.

Oil Bath Enclosures on All Drives.

Sprockets Machine Cut with Hardened Driving Surfaces.

Rotary Drive from the Drum Shaft.

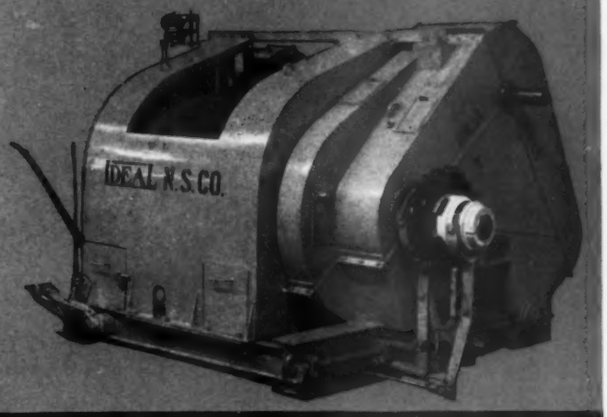
Heavy Duty Self Aligning Roller Bearings on Shafts.

High Speed Drum Shaft and Rotary Drive Sprockets Mounted on Roller Bearings.

Ideal Built-In Water Cooled Brake Rim Circulation System.

Optional Core Bit Drive Sprocket on Line Shaft.

NO. 34-2R-FE



A 4-speed self-contained unit of 250 H.P. capacity embodying refinements which provide quiet and efficient operation, and longer life. Ease of transportation and adaptability to any type motive power make it especially suitable for service in undeveloped and isolated territories.

SALIENT FEATURES OF DESIGN AND CONSTRUCTION

Sprockets with Machine-Cut Teeth and Hardened Driving Surfaces.

Chains and Sprockets Totally Enclosed.

"Cascade" Lubrication of All Chains and Sprockets.

Two Rotary Drive Speeds, with Drive from Drum Shaft.

Automatic Lubrication of the Rotary Drive.

This Draw Works is also equipped with Ideal Compound Equalizing Brakes, self-aligning spherical roller bearings, and drum shaft extension on the driller's side for Hydromatic Brake. The jack shaft is extended on the driller's side to accommodate an engine drive sprocket for use with rotary rig drives. Front drum guard is optional equipment.

THE NATIONAL SUPPLY COMPANY

NSCO
REG. U. S. PAT. OFF.

National

General view showing distillation equipment at Port Isabel Refinery, Coastal Refineries, Inc.

By

J. L. SEWELL*

Refining Practice at

THE Port Isabel Refinery of the Coastal Refineries, Inc., has been designed to process crude from the Sam Fordyce field in Hidalgo and Starr Counties, Southwest Texas. It is situated about 30 miles by paved highway from Brownsville, Texas, at the terminus of the 88-mile oil line of the Valley Pipe Line Company.[1] Crude is delivered to the refinery through this line. The plant has been in continuous operation since early December, 1935, and has a daily capacity of 6000 barrels.

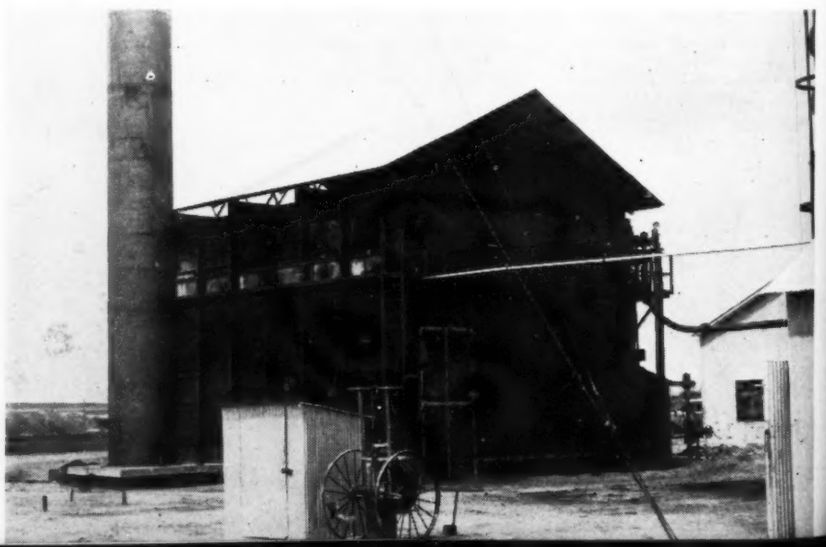
Crude oil from Sam Fordyce field has an average gravity of 21.5 deg. A.P.I. and is practically devoid of gasoline content; some gasoline is obtained by cracking, however. The crude is run to fuel oil of 5-6 deg. gravity A.P.I. In addition, two grades of furnace fuel oil are produced. These four principal products, fuel oil, two grades of furnace oil, and gasoline, are all shipped direct by tanker from the deep-water terminal nearby to eastern markets. Dock and deep-water loading facilities are provided at the terminal, which is only several thousand feet from the plant and has the distinction of being the farthest south deep-water oil terminal in the United States.

A Hempel distillation test of a sample of Sam Fordyce crude in the laboratory is here given:

Gravity	21.5° A.P.I.
Pourpoint	below 0° F.
Hempel distillation sample	600 cc.
Initial boiling point	219° F.
10% off at	457° F.
50% off at	574° F.
85% off at	691° F.
14%	Bottoms
1%	Loss

The results of a further laboratory examination of the properties and percentages of the various cuts are as follows:

Gas Oil	85%
Gravity	25.0° A.P.I.
Viscosity at 100° F.	46 sec. Furol
Color	Light straw
Bottoms	14%
Gravity	9.4° A.P.I.
Viscosity at 122° F.	890 sec. Furol
Pourpoint	65° F.
5% of Gas Oil blended with Bottoms:	
Gravity	13.9° A.P.I.
Viscosity at 122° F.	119 sec. Furol
Pourpoint	15° F.
Gas Oil	80%
Gravity	25.5° A.P.I.
Viscosity at 100° F.	43.5 sec. Furol
Pourpoint	below 0° F.
Color	Light straw



View of the pipe still.

*Plant Manager, Coastal Refineries, Inc.

1"Departure in Pipe Line Construction" by C. J. Holland, *The Petroleum Engineer*, August, 1935.

View inside pump house. All pumps are electrically-driven.

Plant is self-contained and has been designed to process crude to yield fuel oils and gasoline.

Port Isabel Plant

Bottoms	19%
Gravity	10.3° A.P.I.
Viscosity at 122° F.	470 sec. Furol
Pourpoint	15° F.

Although the plant facilities installed are adapted to the handling of Sam Fordyce crude oil, the refinery equipment on the whole is of conventional design. The crude oil distillation unit is a pipe still equipped with bubble-type fractionating towers and efficient heat exchangers.

By referring to the accompanying flow-sheet on page 22, the main steps in the refining process undergone by the crude product can be followed.

The incoming crude oil is first passed through the heat-exchangers and raised to a temperature of 500-520 deg. fahrenheit. It is then charged to the convection section of the pipe still, where on further heating the temperature of the crude is raised to 720 deg. fahrenheit. At this temperature it is flashed into No. 1 bubble tower, where it is fractionated into two straight-run products. The side cut, of 27.5 deg. gravity A.P.I. and representing approximately 30 percent of the charge of crude, is drawn off as No. 2 furnace oil. It is cooled by passing through the first heat exchanger, where it gives up its heat to the incoming crude. The overhead cut, of 43 deg. gravity A.P.I. and representing less than three percent of the crude charge is drawn off as naphtha, whose endpoint is 400 deg. fahrenheit.

From the base of No. 1 bubble tower the reduced crude then goes to the pipe still, which it enters at a temperature of approximately 650 deg. fahrenheit. Here the reduced crude on soaking at a temperature of 890 deg. fahr. and a pressure of 600 lb. per sq. in. is cracked. It then goes to the flash chamber, where the temperature and pressure are regulated to permit an overhead cut of 62 percent of the charge to the chamber. The rest of the charge, representing 25 percent of the crude product, is drawn off at the base of the flash chamber, passed through the third heat-exchanger, where it gives up its heat to the incoming crude and is cooled, then pumped to storage as fuel oil of 5-6 deg. gravity A.P.I. It is interesting to note that the viscosity of the bottom-cut from the flash chamber has a viscosity of only 150 sec. Furol at 122 deg. fahr. as a result of cracking. This is a marked decrease in viscosity compared with that of a straight-run cut of 19 percent obtained from a sample in the laboratory. The viscosity of this cut was 470 sec. Furol at 122 deg. fahrenheit.

From the flash chamber the overhead

View inside power house showing two of the engines and the control panel in the background.

cut goes directly to No. 2 bubble tower, also called the pressure distillate tower. Here the fractionation of the remainder (about 42 percent) of the cracked crude fraction takes place. Two fractions of this cracked crude are taken of No. 2 bubble tower. One, the side cut, is a No. 2 (cracked) furnace oil. This cut undergoes treatment in an auxiliary treater and is subsequently blended with the straight-run No. 2 furnace oil product. The other, the overhead cut, is gasoline and in quantity represents a yield of ten per cent of the crude product. The gasoline is first sweetened in the vapor treater by a special process using lead sulphide and clay, after which it passes through the after-fractionator, where it is stabilized before going to storage.

The bottom cut from the base of No. 2 bubble tower is passed countercurrently to the incoming crude through the second heat exchanger and cooled before going to storage as No. 4 furnace oil.

The bottoms from the after-fractionator are run to slop and later refractionated in No. 2 bubble, or pressure distillate, tower.

The approximate plant yield is as follows:

Straight-run Products:	
Naphtha	2.8%
No. 2 Furnace Oil	30.0%
Cracked Products:	
Gasoline	10.0%
No. 2 Furnace Oil	13.2%
No. 4 Furnace Oil	15.0%
Fuel Oil	25.0%
Loss	4.0%

Gas produced in the cracking process, and accounted for in the four per cent loss shown with the approximate plant yield figures, is utilized for fuel, both in the furnace of the pipe still and in the gas engines. That used in the gas engines is first treated for removal of corrosive or corrosive-forming elements.

In the radiant section of the pipe still there are 180 tubes in wall and roof, and in the convection section 62 tubes in banks of three.

Crude oil is charged initially to the refinery by a reciprocating plunger pump. For charging the reduced crude from No. 1 bubble tower to the pipe still the hot oil pump employed also is of the reciprocating plunger type and is driven by a 200-hp. 4-cycle Diesel engine.

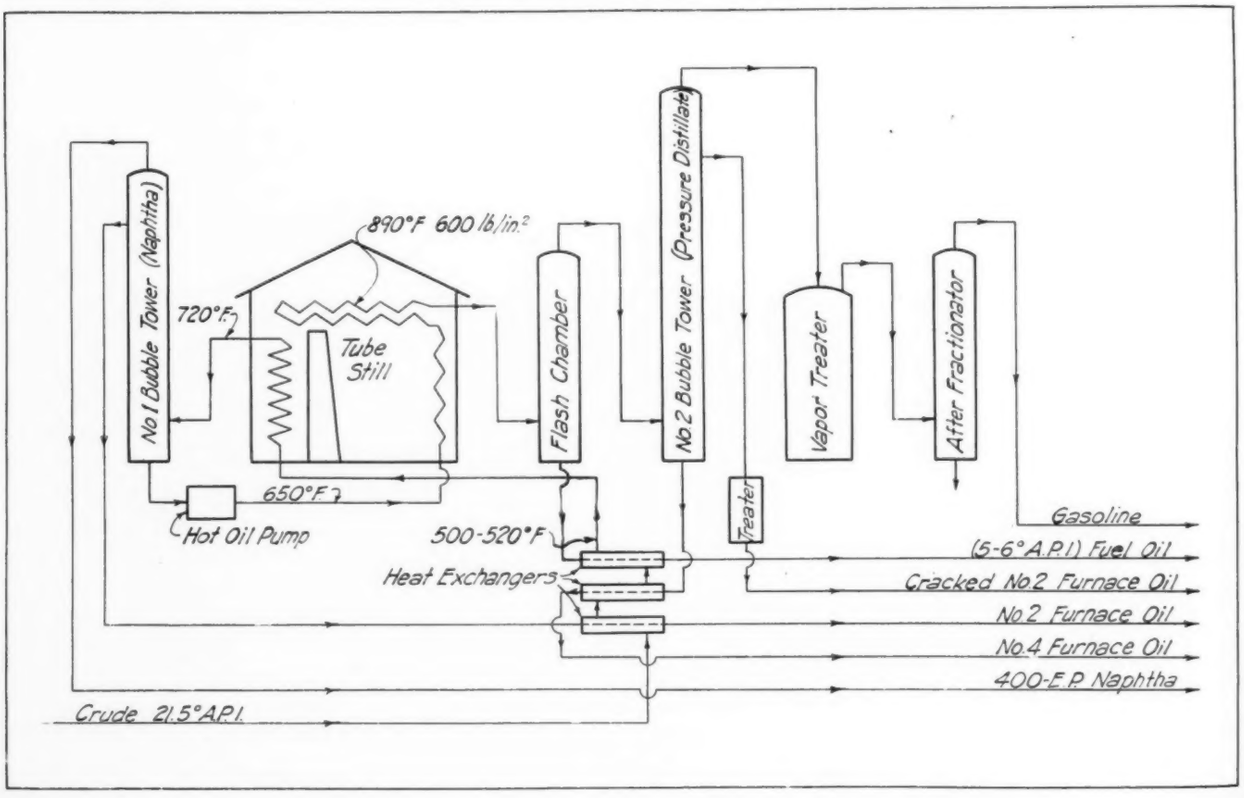
There are some 25 auxiliary pumps for handling the streams in the refinery and these are all electrically-driven. Of the 25 pumps 19 are of the centrifugal type and the remaining six of the rotary type.

All power is generated on the refinery site and practically all refining equipment is electrically-driven and all operations electrically-controlled. Three 150-hp. gas engines direct-connected to generators with V-belt drive between generators and exciters comprise the power plant.

Except for the fresh water used in the closed cooling system of the gas engines and Diesel, and obtained from the city water mains of Port Isabel, sea water is used entirely for cooling. Water from the Gulf is pumped through a 14-in. steel pipe line that is lined inside with spun enamel to prevent corrosion by the salt water. A substantial salt water pump house is erected on the end of the pier, which is only a short distance from the refinery. The cooling pond is equipped with a low cooling tower of ample capacity.

All refining operations are closely controlled, Tagliabue recording instruments that chart all important temperatures and pressures being used throughout. The refinery control panel is amply equipped with instruments so that the trend of all refining operations can be checked at a glance. A well-equipped testing laboratory in charge of a competent chemist is maintained

Flow sheet of Port Isabel refinery operations showing steps in process and resultant products therefrom.



Pier and loading dock, Port Isabel Refinery, Coastal Refineries, Inc.

for checking samples of all refined products and aiding in the close control of refining operations.

Because of the isolated position of the refinery, despite its excellent pipeline connections and deep-water terminal facilities, storage is an important consideration. When the refinery was built the tank storage was 261,000 bbl., including two 55,000-bbl. tanks, two 25,000-bbl., and two 10,000-bbl. tanks. Recently a 55,000-bbl. was added, bringing the total tank storage up to 265,000 barrels.

Loading facilities consist of a pier and loading dock, with three loading lines and electrically-driven centrifugal pumps, and in addition, water, air, and wash lines.

G. L. Rowsey, to whose specifications the refinery was built, is president of Coastal Refineries, Inc. All the refinery construction, and also the fabrication of all the distillation equipment and steelwork including tankage and the terminal, was carried out on a turn-key basis by the Wyatt Metal and Boiler Works of Dallas and Houston under the direct supervision of E. E. Dillman.

Plans have just been completed for the installation of a vapor rectification plant. This unit, which will be designed and erected by Petroleum Engineering, Inc., of Tulsa, Oklahoma, on a turn-key basis, will be utilized for stabilizing pressure distillate and will be the conventional type of high-pressure rectification plant.

Emergency Clamp Saves Run

By

ELTON STERRETT

WHEN the junction tying one pump's discharge line into the 8-in. main line broke, it was evident that, due to crystallization around the fracture, a new section must be fabricated and tied in before the line would be safe to carry its standard working pressure of 900 lb. per sq. inch.

As the cutting, welding, and reinforcing of the new hook-up was estimated to require more time than could be squeezed from the main line's overloaded pumping schedule, the output from the isolated pump was handled temporarily through a 4-in. line from a convenient outlet near the pump to the point where the 8-in. main line had been cut to remove the entire junction assembly.

At the end of the main line the 4-in. line was tied in with a compression coupling, rubber ring packed against leakage, the clamp of the coupling being bolted over an 8-in. by 4-in. swaged nipple and the end of the high-carbon main line, without any preparation whatever, other than cleaning away the protective coating on the steel, so as to allow the dogs on the inside of the collar to find clean steel to grip.

So successfully did the temporary clamp withstand the load imposed on it that the work of fabricating the new tie-in was not rushed, and a Sunday was allowed to intervene; the switch-back being made when the pumping schedule most favored a shut-down.

After completion of the run through the temporary hook-up, the end of the high-carbon main line pipe was examined and the marks of the gripping teeth or dogs in the clamp found to be little more than mere scratched lines around the metal. This was remarkable considering that the end thrust, or total pressure, sustained by the teeth against the pipe during the run was roughly 25½ tons. Ignoring the possible stiffness of the many-jointed swings in the 4-in. line, this load was carried for several days under severe vibration from pump impulses, by the little more than line contact between teeth and pipe surface.

Clamped to the bare pipe, this hook-up withstood a total pressure of more than 25 tons.

Immediately above—View of the Cary compressor plant, Oklahoma City field, during installation of the Cooper-Bessemer compressors.

Top of page—Battery of Clark Bros. compressors under installation in the Cary compressor plant, Oklahoma City field.

Development of the Capitol extension of the Oklahoma City field is awakening interest there in gas-lift. Five plants are in course of erection and it is predicted others will be needed as soon as wells stop flowing naturally. Some wells may require use of gas-lift from time of completion.

This article gives some interesting data on installation and operating costs on gas-lift plants.

Compressor Plant of 4700-Hp. Capacity In Use Exclusively for Gas-Lift Operations

By S. F. SHAW*

ONE of the largest plants in the world employed exclusively for gas-lifting oil is the Cary compressor plant in the Oklahoma City field. Owned jointly by the Westgate Oil Company and the Natural Gas Development Corporation, the plant has 24 compressor units, aggregating about 4700 hp., consisting of ten Clark Bros. 230-hp. duplex two-stage compressors; 11 Cooper-Bessemer, 165-hp. type 10, duplex, two-stage compressors; and three Ingersoll-Rand 190-hp. type XVG-3, three-stage compressors.

*Consulting Engineer, Westgate Oil Company.

CLARK BROS. UNITS. In these units the compressors are provided with two-cycle power cylinders, 17-in. by 20-in. stroke, and equipped with fuel injectors, requiring fuel intake pressure of about 15 lb. Their operating speed is approximately 200 r.p.m. The low-stage compressor cylinders are 16-in. by 20-in. stroke, and the high-pressure cylinders 7½-in. by 20-in. stroke. Each end of the high-pressure and low-pressure compressor cylinders is equipped with clearance pockets, the design being such that intake gas at a pressure of 0 to 20 lb. can be employed, giving a discharge pressure of 350 to 500 lb. per sq. inch.

The design of the header arrangement is such that if a discharge pressure in excess of 750 lb. is required, the gas from four of the units can be admitted to the intake of the high-pressure cylinder of a fifth unit and stepped up to whatever pressure is required. There has been occasion for this procedure only a few times since the plant was started.

These compressors were the first installed in this plant. New machinery, rather than used machinery, was selected, on the basis of eliminating any doubt regarding performance at the beginning of operations, owing to the importance of production on the Cary lease. The first five units were put into operation April 1, 1934, and the second five units on March 27, 1935. The time required to install each bank of five compressors was about 50 days. These ten compressors, fully equipped as new machinery with cooling tower and circulating pumps and intercoolers, cost approximately $165,000.

With an intake pressure of 8 lb. and a discharge of 400 lb. the ten compressors have a capacity of approximately 11,800,000 cu. ft. per day on atmospheric pressure base.

Water for cooling gravitates through the intercoolers and the water

Unit of the Cary compressor plant, Oklahoma City field, containing Ingersoll-Rand compressors

jackets of the compressor and power cylinders to a hot well, 25 ft. by 8 ft. by 5½ ft. deep, whence it is picked up by one of two centrifugal pumps and distributed over a Pritchard cooling tower. Two Pennsylvania 5-in. centrifugal pumps, capacity 1200 gal. each per min., lift the water to a height of 75 ft., with pumps running at speed of 1400 r.p.m. These pumps are driven by two 40-hp. horizontal four-cycle gas engines.

Gas intake to the compressors passes through a 10-in. meter loop and through a 6-in. pilot-controlled regulator to the 16-in. intake header and thence to the low-pressure cylinders. It then flows to a 10-in. intermediate discharge header and through four Tulsa-type intercoolers, each of 367 sq. ft. surface, to four 3-ft. by 8-ft. scrubber tanks, thence to the 10-in. intermediate-pressure intake header from which it is taken to the high-pressure compressor cylinders, whence it is discharged into an 8-in. high-pressure header. The gas then goes through two 6-in. meter loops and finally through two 3-in. lines and one 4-in. line to the various wells on the lease.

Air for starting is supplied by a 4½-in. by 2¼-in. by 3½-in. compressor, speed 250 r.p.m., pressure capacity of 250 lb. per sq. in., and is driven by a V-belt from a 3½-in. by 4-in. industrial-type gas engine.

There are two 5-kw. 125-volt, 1800 r.p.m., electric lighting generators, each of which is driven from the flywheel of one of the 40-hp. engines. These generators supply the lights at night.

COOPER-BESSEMER UNITS. The power cylinders on the engines, which are two-cycle, are 16-in. dia. by 20-in. stroke. The low-pressure compressor cylinders are 13½-in. dia. by 20-in. stroke, and the high-pressure cylinders 6¼-in. dia. by 20-in. stroke. Locally-made clearance pockets, 3-in. dia. by 18 in. long, are attached to each end of the low-pressure compressor cylinders. The intake pressure is from five to seven lb., the discharge pressure from 350 to 500 lb. per sq. in., and the operating speed about 190 r.p.m.

These compressors had been in operation in the Seminole field for two or three years. Some of the power cylinders were replaced or rebored and other repairs made when installed on the Cary lease, where they are giving satisfactory service. The first six units were placed in operation on August 23, 1935, and the next five on December 10, 1935. The time required to erect the first set of six units was 42 days, and 40 days to install the second five units. The cost of the 11 units installed, complete with cooling tower, etc., was approximately $70,000.

Operating with an intake pressure of 7 lb. and a discharge pressure of 400 lb. the output of the 11 units is approximately 8,250,000 cu. ft. per day.

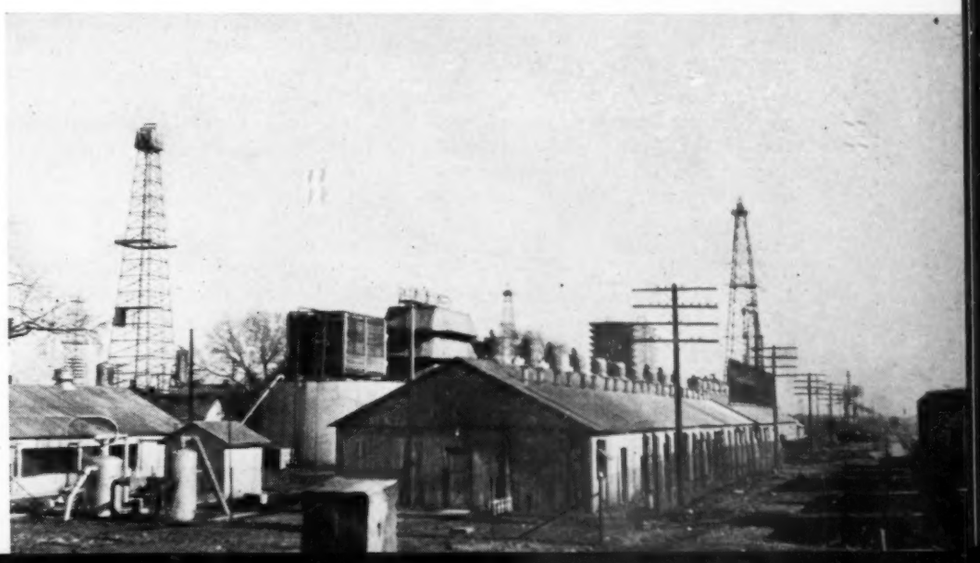
The gas is admitted to these units through two scrubber tanks at each end of the intake header, and is controlled by two regulators, one of which is a Davis 6-in. remote pilot-valve-controlled regulator ranging from 10 lb. to one oz. pressure.

From the intake header, which is 16 in. in dia., the gas after passing through the compressor, is discharged from the low-pressure cylinders into a 10-in. header from which it goes to four Tulsa-type single-pass tube sections placed in a Marley cooling tower. From there the gas goes to a 3-ft. by 8-ft. scrubber tank, thence to another 10-in. header from which it enters the high-pressure cylinders, and is then discharged into a 6-in. high-pressure discharge header.

Gas for fuel is drawn through a 3-in. fuel line to two 2-in. regulators, and then to a 10-in. fuel header, whence it is received by the power cylinders. Air for starting these 11 units is supplied by a Fairbanks-Morse 3¾-in. by 3⅜-in., 475 r.p.m., compressor, pressure rating 250 lb., driven by a 3-hp. gas engine at 800 r.p.m.

INGERSOLL-RAND UNITS. Each of these three compressor units has six, four-cycle, power cylinders, 11-in. by 12-in. stroke. One of the units has two low-pressure compressor cylinders, 10-in. dia. by 12-in. stroke, and a high-pressure cylinder, 5½-in. by 12 in. stroke. Two units employ three-stage compression, the low-stage cylinders being 14-in. dia. by 12-in. stroke. Individual intercoolers are used between the low-pressure and high-pressure cylinders. The operating speed of the engines is 300 r.p.m. The intake pressure varies from 0 to 10 lb. and the discharge pressure from 350 to 500 lb. A valve lifter is provided in one of the low-pressure 10-in. by 12-in. cylinders and clearance pockets are provided in the 8½-in. by 12-in. cylinders. Locally-made clearance pockets are attached to the 14-in. by 12-in. low-pressure cylinders. The capacity of the three units is 3,500,000 cu. ft. per day at 5-lb. intake and 400-lb. discharge pressure.

These compressors were moved from another plant in the Oklahoma City field where they had been in continuous operation for about 18 months. They were placed in operation in the Cary plant on November 25, 1935. To install the three compressors required 15 days from the time excavation of the pits was begun until the units were in operation. Their instal-



General view of the Cary compressor plant of Westgate Oil Company—Natural Gas Development Company in the Oklahoma City field

Cary compressor plant, Oklahoma City field

lation cost complete at the Cary plant was approximately $30,000.

The intake gas to the compressors passes through a 5-ft. by 6-ft. scrubber tank, from there to a 4-in. regulator, then to a 10-in. intake header, and thence to the low-pressure cylinders. From each low-pressure cylinder the discharge goes through a 6-in. line to individual Ingersoll-Rand, type 10, intercoolers having a pressure capacity of 200 lb., and then through 4-in. lines to the second-stage cylinders from which it is discharged without intercooling to the third-stage cylinders. From the third-stage cylinders the high-pressure gas goes to a 6-in. header, thence through a 6-in. orifice meter loop, and then to the various lines that pass through the lease.

The fuel gas from the 5-ft. by 6-ft. scrubber passes through a 2-in. regulator to the intake (8-in.) header, thence through individual 1½-in. regulators on each engine, from one lb. to one oz. pressure to the power cylinders.

Both the intake and discharge water headers are 6-in. in diameter. The discharge water header delivers the water to a hot well, 8 ft. by 8 ft. by 5 ft. deep, from which it is pumped by one of two centrifugal pumps to a 12-ft. by 16-ft. by 12-ft. cooling tower of the boxed-in type, whence it falls into a 2000-bbl. storage tank.

Air for starting is supplied by a 3-in. by 4-in. compressor driven at 1000 r.p.m by a 3½-in. by 4-in. gas motor. The pressure capacity of this starting unit is 200 lb. per sq. inch.

Water from the city mains was employed during the first year of operation of the plant. As the size of the plant was increased, cooling water requirements also increased until it became profitable to drill a water well on the compressor grounds. This well is 750 ft. deep and is cased with 5 3/16-in. casing, and has capacity of about 3000 bbl. per day. The water is being lifted by gas-lift, but as requirements for gas increase on the lease it may become necessary to install a centrifugal deep-well pump.

The water that was drawn from the city main was treated with compound after a formula supplied by the Dearborn company. No chemical treatment is required for the deep-well water.

Although all the compressors in the Cary plant are situated on one site, the different types of compressors were set up in different buildings in order that the construction of each plant would interfere to a minimum extent with the operation of the other compressors. It was also anticipated that as oil production declines and the requirements for gas are reduced, there will be a gradual dismantling of the plant and transfer of the machinery to other sites where needed.

It has been necessary at times to purchase part of the requirements of the wells on the lease for high-pressure gas from a commercial pipe line. This gas was priced at eight cents per M. cu ft. on 2-lb. pressure base, equivalent to seven cents on atmospheric base.

The operating costs of the Clark Bros. units are about one cent per M. cu. ft., leaving a profit of six cents per M. cu. ft. to apply on the cost of the plant; thereby requiring the compression of 2,750,000 M. cu. ft. to pay out. This required approximately 14 months, owing to the fact that there was a low-load factor during the first year of operation, the requirements for gas for lifting oil being rather irregular. Since the end of the 14-month period mentioned, the plant has been operating at a load factor of close to 100 percent.

The cost of the first six Bessemer units was approximately $38,000. On the basis of six cents profit per M. cu. ft. it was necessary to compress 633,000 M. cu. ft. to pay out, and since the capacity of these six units was close to 150,000 M. cu. ft. per month, with a load factor of nearly 100 per cent, the time required to pay out was about four months.

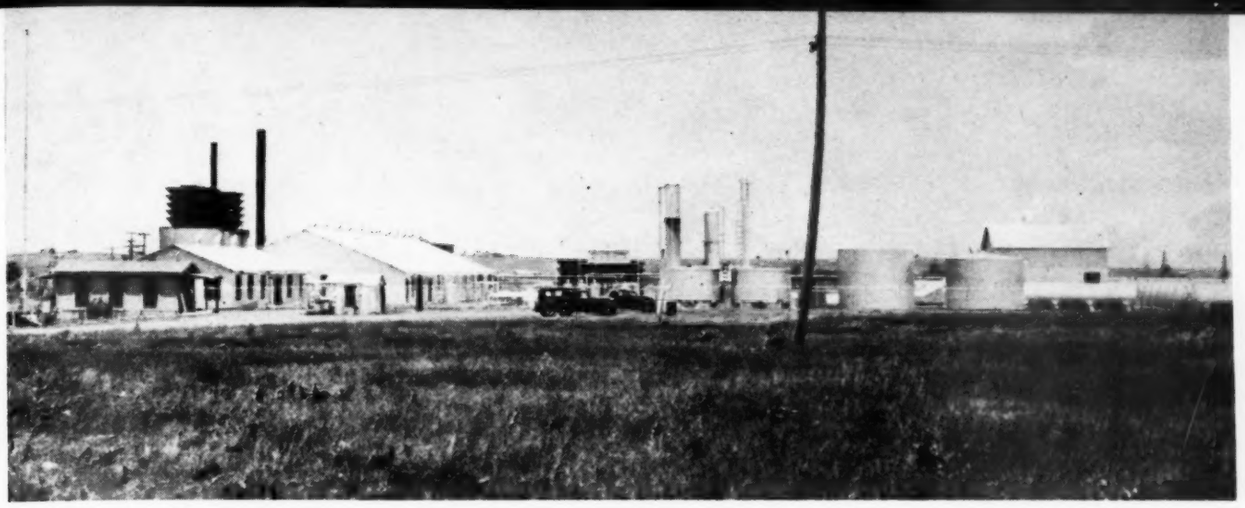
The installation cost of the Ingersoll-Rand plant was approximately $30,000, and at a profit of six cents per M. cu. ft., it will require approximately 500,000 cu. ft. to pay out. The capacity is approximately 120,000 M. cu. ft. per month, and with load factor of 100 percent, the time required to pay out is approximately four months.

As already stated, the Cary plant has a capacity of approximately 4700 hp. This may be compared to the power generated by No. 3 Cary well, which came in for a production of approximately 100,000 bbl. per day under an initial bottom-hole pressure of about 2600 lb. and a gas-oil ratio of probably 1000 cu. ft. per barrel. The expansion of this quantity of gas per day from 2600 lb. to atmospheric pressure would be the equivalent of approximately 25,000 hp., consequently the Cary compressor plant, large as it may seem, is a very small power plant compared to the power generated by the gas accompanying the oil from the twelve wells on this lease.

The quantity of gas compressed in the Cary plant during 1934 was 522,906 M. cu. ft. and in 1935 was 3,928,943 M. cu. ft. The quantity of oil produced on the Cary lease has been as follows:

1931-1933	1,345,176 bbl.
1934	1,088,771 bbl.
1935	2,611,852 bbl.
Total	5,045,799 bbl.

Gas-lift operations were started on April 1, 1934, on well No. 4 Cary, and have gradually increased in scope as time has passed and wells have ceased to flow naturally. At the present time, gas is employed for gas-lifting oil in wells that are capable of making from 1000 to 5000 bbl. per day with a bottom-hole flowing pressure of 120 to 150 lb. per sq. inch. From data at hand it would appear that in wells completed with casing of the larger sizes it will be possible to lift on continuous gas-lift, fluid with bottom-hole flowing pressure of 40 lb. at approximately 300 bbl. per day. The quantity of gas required will range probably from 12,000 to 15,000 cu. ft. per bbl. at this flowing pressure, and cost approximately 12 cents to 15 cents per bbl., based on compressing gas at one cent per M. cu. ft. in the Cary compressor plant. As a matter of fact the operating cost at present is close to ¾ cent per M. cu. feet.



General view of Skelly Oil Company's Naphtha gasoline plant in Osage County, Oklahoma

Gasoline Plant Efficiency Improved

Minor Changes Made in Old Existing Plant Facilities Add to the Efficiency and Simplify Operations

By J. C. ALBRIGHT

ALTHOUGH nothing of a spectacular nature has been done to improve the efficiency of the Naphtha gasoline plant at Carter Nine, Osage County, Oklahoma, since Skelly Oil Company took over the management and operation of it June 1, 1935, several minor changes have been made that add to the efficiency of operation. The plant, situated in the southern end of the old Burbank pool, takes gas from a number of wells that have been producing consistently since the field was discovered. Adjacent to the area, and to the southeast, is the South Burbank pool, which supplies some of the gas processed in the Naphtha plant.

One of the first changes made was the conversion of the method of cylinder jacket cooling from a forced-feed semi-closed system to a gravity system. A comparatively small hot well was constructed immediately outside the building housing the compressors and engines to replace the bottom ring of a "55" tank originally used to catch the water flowing through the cylinder jackets. This hot well is equipped with a float-controlled valve operating on the discharge of the water circulating pumps. Cooling of the jacket water is done by means of two steel tanks with louver towers above them on a superstructure of steel.

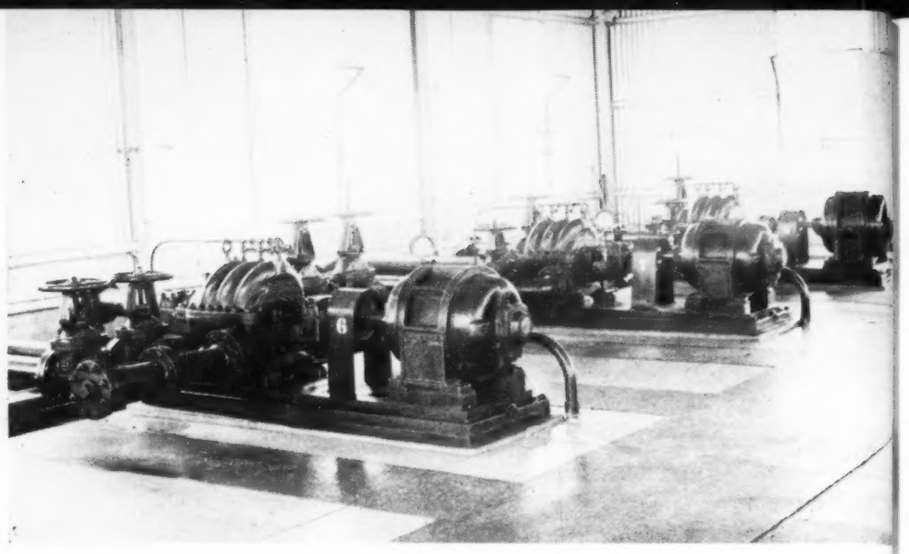
In the original design of the plant, a large louver tower was erected near the engine room for cooling the jacket water. This tower has been removed, the basin filled with soil, and flowers planted. Chat, or crushed native limestone, has been placed on the yard of the plant to prevent mud from being carried into the various buildings and to reduce erosion resulting from rainfall. The floors of the building not covered with concrete have been refinished with finely crushed limestone and tamped to a smooth water-bound surface.

Steam is used mainly for processing the rich mineral seal oil, and to operate spare pumps in emergencies. Condensate and low-pressure steam both are carried through piping to the boiler room to be re-used. A vertical column employed for a boiler feedwater makeup tank has been installed at one end of the boiler room. It receives the condensate and steam and blends them with makeup feedwater to the boilers. Two liquid level "kidney valves" have been placed on the side of this tank, the lower acting as a low-water indicator, while the upper feeds fresh water to the tank and acts as a high-water indicator. A low-pressure steam whistle has been installed on the top of the tank, operated by both the high- and low-water indicators through wiring attached to the arms of the floats in the cages. With the use of this feed tank but a slight volume of steam is lost to atmosphere, and, since it is enclosed, the water is prevented from becoming saturated with oxygen, thereby reducing corrosion of feed lines and fittings to a considerable extent.

A complete electrical generating system is a part of the plant's equipment, supplying power for operation of pumps within the plant, as well as for pumping many of the wells on surrounding leases. Plans are being made to increase the voltage of the current carried to the field and to divide the power so that some of the units may be shut down during periods of light current requirements. Four units have been installed for electrical generation, housed in a building separate from the gas-engine-driven compressors and auxiliary engines.

Two separate water-cooling systems have been provided, one for that used in cooling the gas before it enters the absorbers, the other for water passing through the units for cooling the mineral seal oil. More satisfactory temperatures are obtained in this manner than before the systems were made separate. The louver tower installed last year has been placed so that the prevailing winds can blow through the unit from one side, rather than down the length. In this manner more rapid evaporation is obtained and hence a greater cooling effect.

Oil drained periodically from the



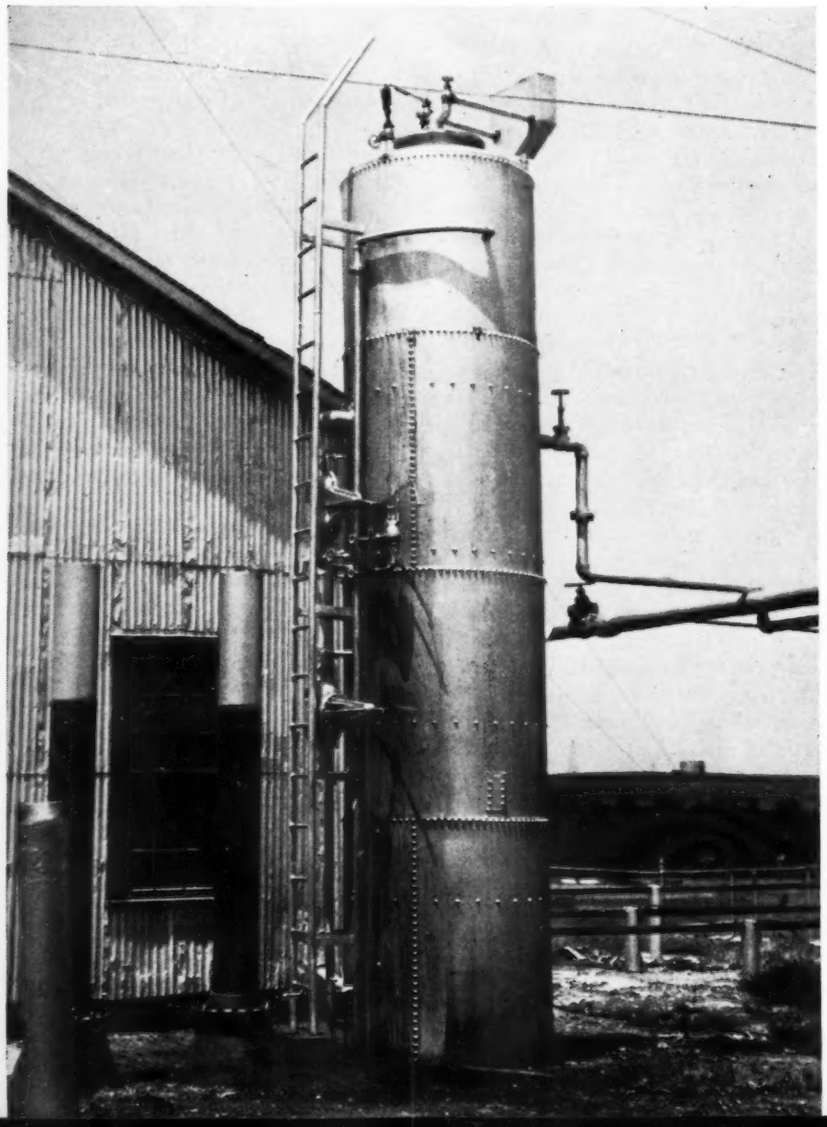
Electric-motor-driven centrifugal pumps—Skelly Oil Company's Naphtha gasoline plant, Osage County, Oklahoma

crankcases of the numerous engines is saved and subsequently reclaimed. Lighter fractions are eliminated from the oil by means of steam before it enters the apparatus employed for removal of free carbon and for decolorizing. Tests made of the reclaimed oil reveal that it is as well suited for heavy-duty engine crankcase service as fresh oil, and by using a reclamation unit, expenditures for oil have been reduced considerably.

Additional field lines have been laid, resulting in the main vacuum systems giving improved service in the removal of gas from the various casingheads and field traps, at the same time avoiding the danger of pressures in some parts of the field and a higher vacuum at others. To reduce the difficulty of vacuum and residue lines freezing in winter due to pipe line hydrates, denatured alcohol lubricators have been installed in the field; definite quantities of alcohol can thus be introduced with the gas to lower the temperature at which the hydrates will freeze. Night work and pipe line maintenance were reduced to such a degree the past winter, after this system was placed in operation, that constant service was maintained except for an occasional trip to thaw out a "freeze" in a line.

The gasoline manufactured requires little treating, ordinary bleaching powders being employed for the purpose. The plant was designed originally so that sodium hypochlorite could be prepared from dissolved caustic and liquid chlorides, or the solution be prepared by using any of the commercial sodium or calcium hypochlorites. The vertical tank used when mixing the liquid chlorine with the caustic solution is now used in dissolving the bleaching powders, stirring and mixing being accomplished by adding water through a hose to the bottom of the tank after the required quantity of powder has been dumped into the mixing tank. As soon as the the bulk of the usual undissolved material has settled to the bottom of the tank, the liquid is drawn from the vessel to a horizontal one used as a supply tank. Additional settlings may be blown as sludge from the bottom of this tank to the plant disposal lines, together with the sludge from the mixing vessel. Treating solution is drained from this tank as required into a blow case beneath the surface of the treating-room floor, and a definite volume can be added to that in the treating columns through which the gasoline is pumped.

Most of the natural gasoline production from the plant is shipped by pipe line without stabilizing to the Skelly Oil Company's specialty plant at Lyman, in the north end of the Burbank field, where the different hydrocarbons are removed when making Skelgas, butanes, and other products. The raw product varies in vapor pressure according to the amount of propane removed from the gas processed, but averages from 35 to 40 lb., Reid.



Boiler feed water tank equipped with dual float valves for low-water and high-water alarms.
Story No. 1308

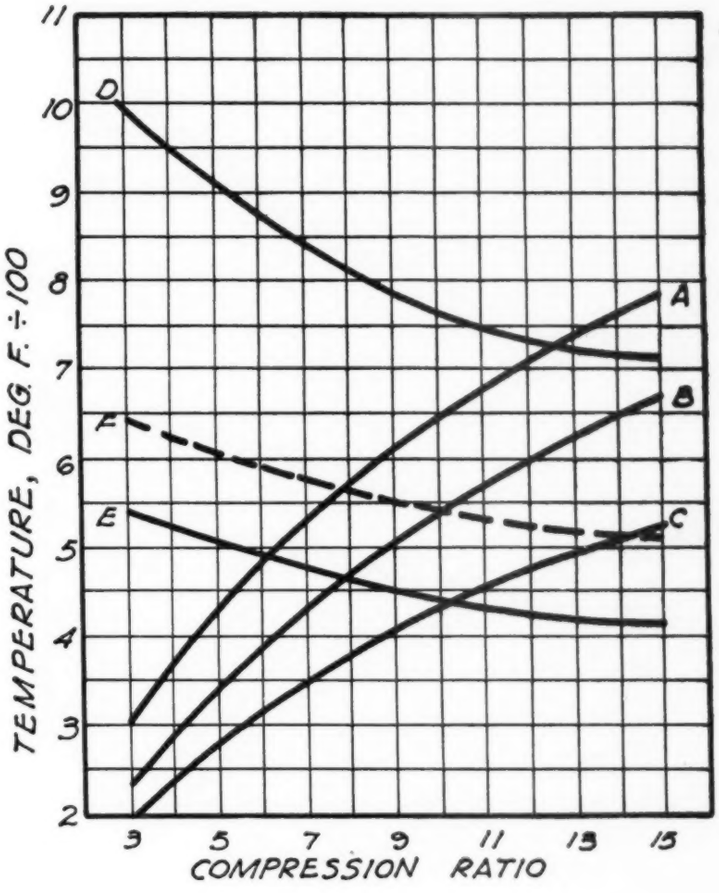


Fig. 13. Effect of compression ratio, compression temperature, and type of fuel on the starting and ignition characteristics of the Diesel. *(See discussion on this and the following pages)*

By

JOSEPH LISTON

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Part 4

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Fundamentals of the Internal Combustion Engine

LIMITING FACTORS IN THE ACTUAL DIESEL ENGINE

IT has been shown that, for the theoretical Diesel cycle, the power output and efficiency may be increased by increasing the compression ratio. It is also seen from Fig. 12 that the efficiency may be increased by decreasing the time for combustion. In the actual Diesel engine cycle increased power and efficiency may be had by increasing the compression ratio, and the improvement parallels the theoretical variation, but, for any given compression ratio, the power and efficiency will be less than the theoretical values.

As with engines operating on the Otto cycle, the Diesel is limited in the range of compression ratios that can be satisfactorily used. The lower limit is largely determined by the minimum compression temperature that will suffice to ignite the fuel. The compression temperature will have to be at least as high as the spontaneous ignition temperature (Abbreviation S. I. T.) of the fuel.

Fig. 13 illustrates the ignition possibilities in the Diesel. Curve *A* shows the variation in compression temperature with compression ratio when the initial temperature (atmospheric temperature) is 80 deg. fahr. and the exponent of compression $n = 1.3$. Curve *E* is the S.I.T. of a gas oil, and *D* is the S.I.T. of a coal tar oil. The minimum compression ratio at which ignition can take place is that ratio which gives a compression temperature just equal to the S.I.T. of the fuel. For the gas oil in Fig. 13, the minimum compression ratio is about 6, and for the coal tar oil, the ratio cannot be less than about 12.5.

In actual operation of the full Diesel, these low ratios would be unlikely to give satisfactory starting. When the fuel is sprayed into the combustion chamber, it is in liquid form and must be evaporated. The latent heat of evaporation is supplied by the compressed air in the combustion chamber and this lowers the temperature of the air. Hence, if the compression temperature is just equal to the S.I.T. of the fuel, ignition will be uncertain—especially in starting. Once started, of course, the residual heat from previous cycles will aid in firing the new charge.

An engine with worn piston rings or other means of escape for the air during compression will result in a compression pressure less than the compression ratio would indicate. This loss of compression pressure will lower the compression temperature and lessen the chance of ignition.

These and other factors such as cold cylinder walls during the starting period necessitate using a compression ratio that will give a compression temperature well above the S.I.T. of the fuel.

Curve *F* is curve *E* displaced upward 100 deg. fahrenheit. If this represents the difference in compression temperature and S.I.T. for reliable ignition, the minimum compression ratio for the gas oil will be about 8. The same temperature difference for the coal tar oil will push the minimum compression ratio above 15. Due to the chilling action of the highly compressed air used for injection, the temperature difference for air injection en-

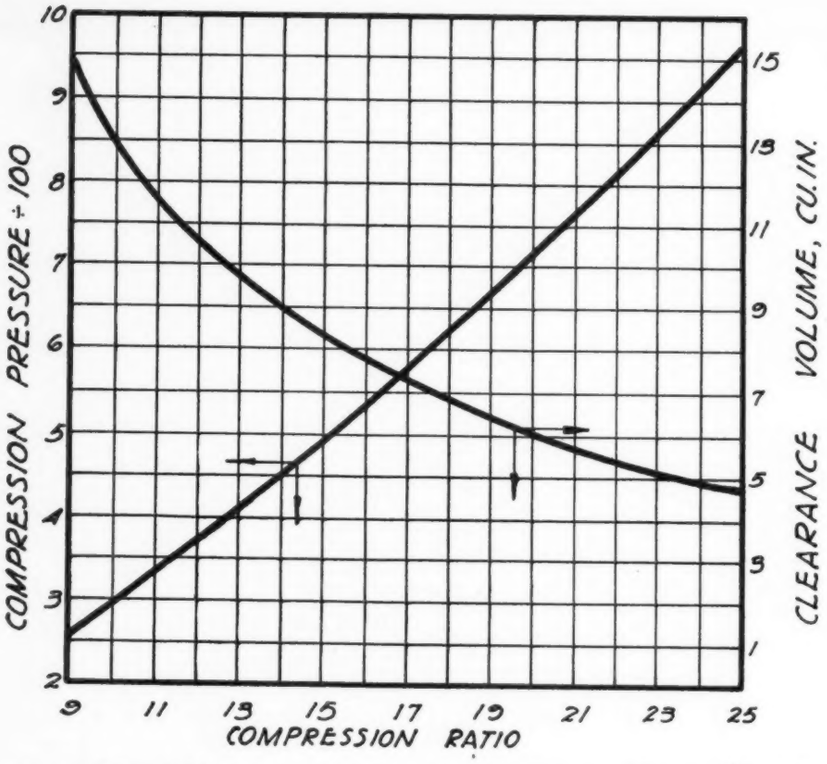


Fig. 14. Variation of compression pressure and clearance volume for a 5-in. by 6-in. engine with compression ratio.

gines would probably have to be 200 degrees or more.

As soon as the engine has fired a few times, the hot clearance gases will raise the compression temperature well above the calculated values in Fig. 13 and the minimum ratio can be lowered; however, with this lower ratio, the engine cannot be started except with auxiliary heat.

The effect of lowered atmospheric temperature is shown by curve *B*, Fig. 13. This curve represents the compression temperature for an initial atmospheric temperature of 40 deg. fahr. and an exponent of compression of 1.3. To provide the desired 100 deg. above S.I.T. of the gas oil, a compression ratio of 10.2 is necessary as against a ratio of 8 when the atmospheric temperature is 80.

The assumption that the exponent of compression is 1.3 is based on measurements of indicator cards taken when the engine was warm. In starting, however, the cold cylinder walls and clearance gases will materially reduce this value. Curve *C* is based on an initial or atmospheric temperature of 40 deg. fahr. and a value of $n = 1.25$. To get satisfactory ignition with gas oil, a compression ratio of 14 would be desirable. As there are many Diesels operating at compression ratios less than 14, the necessity of using auxiliary heat in starting during cold weather is obvious.

Few Diesels in this country are operated on coal tar oil, but this fuel is used in Europe, and the problem of starting is of interest. From Fig. 13 it is seen that curves *C* and *D* would have to be extended to a very high compression ratio before they would intersect. Such ratios are impractical because of the excessive cylinder pressures developed, and, to get satisfactory ignition, some other means must be used. One method is to mix a small quantity of gas oil with the tar oil. The gas oil would then serve as an "ignition oil" to start combustion.

The upper limit of compression ratio in the Diesel is determined by a number of factors. Increasing the compression ratio increases the compression pressure as shown in Fig. 14. Above ratios of 15 or 16 the high-compression pressures necessitate very strong and heavy cylinder construction, and this extra weight is more or less objectionable depending upon the use to which the Diesel is put.

Another limiting feature is the relatively small space in the combustion chamber, Fig. 14. In most designs of Diesel injection systems it is not desirable to have the fuel spray strike the walls of the combustion chamber. The reason for this is that during the combustion period the combustion chamber walls are at a lower temperature than the charge of air. Hence, if the fuel spray strikes the walls, it will be cooled below ignition temperature and not burn effectively. In addition it has much less chance of mixing with the air and this will prevent complete combustion. The problem of keeping the fuel spray from striking the combustion chamber walls is most acute in the small high-speed Diesel. In this type of engine the compression ratio may be quite high to increase the density of the charge and thus reduce the penetration of the fuel spray.

The problem of properly injecting the fuel and mixing it with the air in the combustion chamber has been and, to a considerable extent, continues to be one of the major obstacles in the way of increasing the performance of the Diesel engine. In the Otto cycle engine operating on the 4-stroke cycle principle an intake and compression stroke representing some 360 deg. of crankshaft travel are available for mixing the fuel and air. Approximately the same time is available in the Otto cycle two-stroke engine if the fuel is supplied to the compressor cylinder, and, even if the fuel is supplied direct to the power cylinder, as in engines equipped with so-called "fuel savers," most of the compression stroke is available for mixing.

However, in the case of the full Diesel, the fuel is not admitted to the cylinder until near the end of the compression stroke. Obviously, the time available for mixing the fuel and air is much shorter in the Diesel. Hence, for a given set of conditions, less effective mixing results and, since the fuel cannot burn if it does not come in contact with the air, poor mixing results in incomplete combustion.

Fig. 15 shows the approximate time in fractions of a second available for mixing the fuel in Otto and Diesel cycle engines, mixing being assumed to continue until the end of the combustion period.

In addition to the relatively much shorter time for mixing the fuel in the Diesel, this type of engine has the added disadvantage of using a fuel that is much less volatile. In the gas engine the fuel is already in gaseous form and needs only to be mixed with the air. In the gasoline engine the fuel is almost completely vaporized by the time it enters the cylinder. In the Diesel, however, the fuel enters the cylinder as a liquid and must be vaporized as well as mixed with air.

Many methods such as finer atomization and better distribution of the fuel spray, high velocity controlled turbulence of the air, and special combustion chamber shapes designed to fit the form of the fuel spray have been

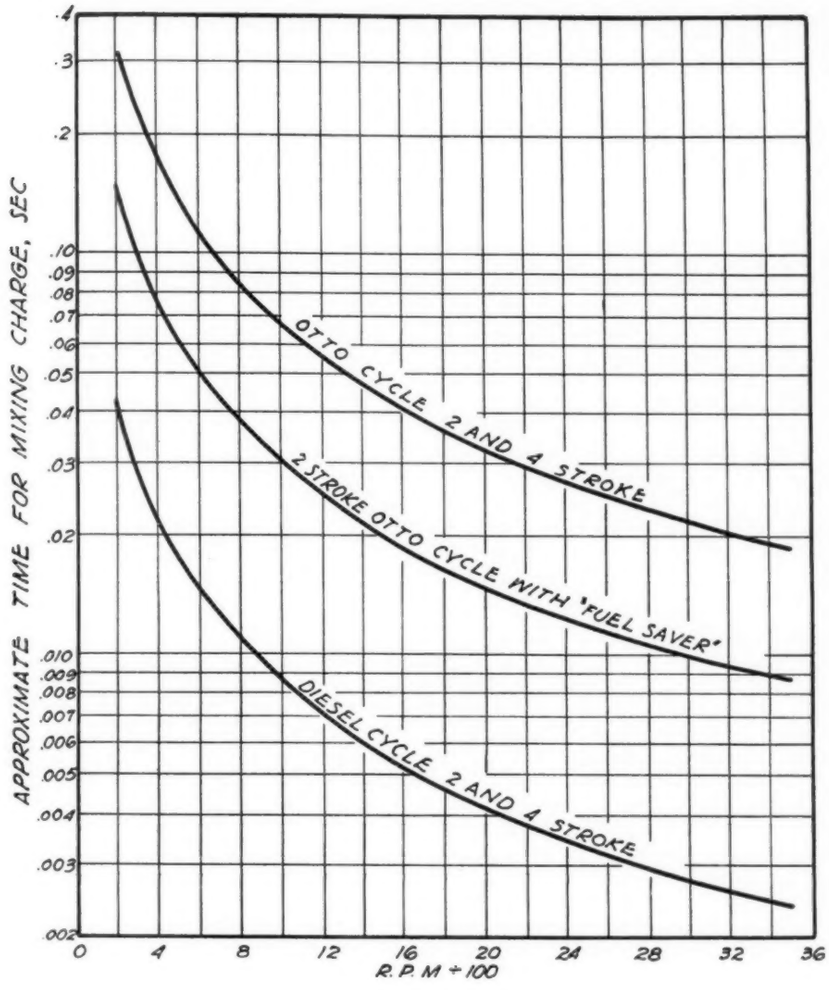


Fig. 15. Effect of engine speed and type of cycle on fuel-air mixing time.

used to increase the rate of mixing of the fuel and air in the Diesel, but very few designs have been made that are able to overcome entirely the mixing time disadvantage of the Diesel. The result is that nearly all Diesels must use an excess of air to obtain smokeless combustion.

The effect of using excess air is to reduce the specific power output, i. e., the b.hp. per cubic inch of piston displacement, for any given speed, will be less in the Diesel than in the gas or gasoline engine, other factors being equal. The effect of using large amounts of excess air may be shown in another way noting the reduction in heating value of the air-fuel by mixture with increasing percentages of excess air, Fig. 16. For a given size of cylinder, as the percentage excess air is increased, the heat energy in the charge will decrease, and, obviously, less useful work can be obtained from the charge. As the excess air is reduced in the Diesel, the heat energy entering the cylinder increases, but due to the difficulties of mixing the air and fuel, more and more unburned fuel escapes to the exhaust as smoke and the efficiency decreases.

One method of increasing the time available for mixing is to advance the injection timing. Some advance is necessary as the speed is increased, and this is comparable to advancing the spark in the variable speed gas or gasoline engine; but, if the injection timing is advanced too much, the effect is to allow too great a portion of the fuel to "pile up" in the cylinder and burn all at one time. Essentially, with too early an injection timing the Diesel engine acts more like a high-compression Otto cycle engine and instead of combustion occurring at constant pressure, according to the theoretical Diesel cycle, it more nearly approaches constant volume combustion, as in the theoretical Otto cycle; hence the maximum pressure in the early injection Diesel is much higher than the compression pressure. In some of the higher-speed Diesels where the mixing time is normally very short, Fig. 15, the injection timing has been advanced so far that maximum pressures of 1200 to 1500 lb. resulted. Obviously, the stress and shock on the engine mechanism are very severe.

Metering and injecting the liquid fuel becomes an increasingly difficult problem as the speed of the Diesel is increased. For instance, in an 80-hp single cylinder, 4-stroke cycle Diesel

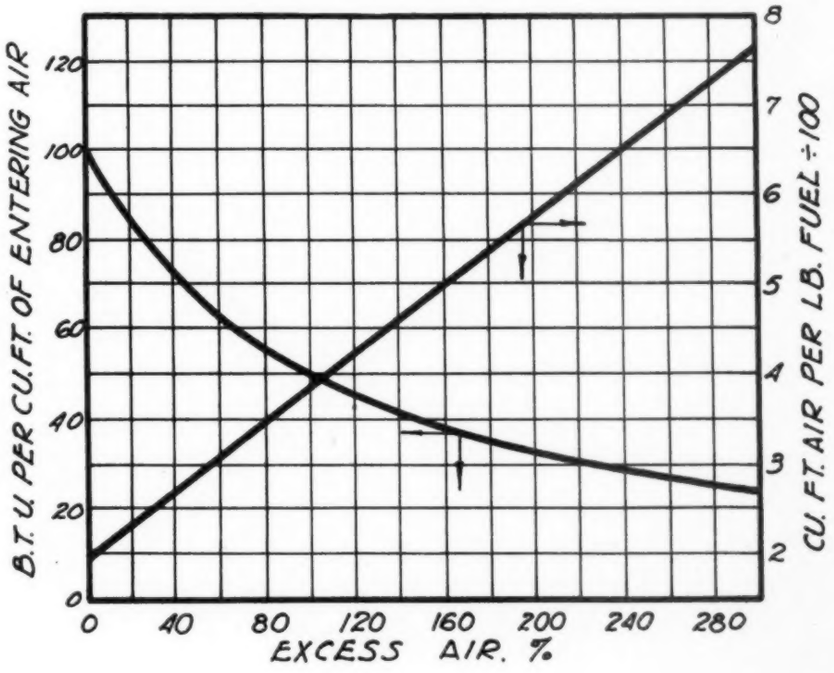


Fig. 16. Effect of excess air on the heat energy taken into the Diesel cylinder per unit of displacement.

operating at 250 r.p.m. and using .42 lb. of fuel per hp-hr., the fuel injected per cycle at full load is .00448 lb. = .1446 cu. in. for a fuel of 33 gravity A.P.I. In an 80-hp 6-cylinder, 4-stroke cycle Diesel operating at 1200 r.p.m. and using .42 lb. of fuel per hp-hr., the fuel injected per cylinder per cycle is .001555 lb. = .0501 cu. inch. This is about the size of a drop of oil one-fifth inch in diameter.

In addition to metering very accurately these small quantities of fuel, the injection pump must force them into the cylinder at several thousand pounds pressure and at a precise time that should not vary over a few ten-thousands of a second from cycle to cycle; also, in multi-cylinder engines, to avoid roughness, exactly the same amount of fuel must be injected into each cylinder. The precision in injection pump manufacture necessary to accomplish this is comparable to that necessary in building a fine watch.

It has not been the purpose of this discussion to minimize the possibilities of the Diesel but rather to explain some of the limits and point out some of the obstacles that largely have been overcome by the designers and builders of the many successful Diesels now in service.

Pivoted Motor Calculations Simplified

By W. F. SCHAPHORST

NOW that pivoted motors are coming into greater use in refineries and oil plants, requests are increasing for "explanations" concerning the automatic rocking action of the motor, shown in Figs. 1, 2, and 3, accompanying.

When the motor is idle, Fig. 1, the belt is unstretched, and the center of gravity of the motor is almost directly above the hinge. That is, the distance L is smallest, just as it should be.

Upon starting, Fig. 2, the motor automatically "backs into the belt," and the distance L becomes greatest. In other words, the motor does precisely what it *should* do for best results.

Finally, when the load becomes normal, Fig. 3, the motor swings slightly toward the right, and the distance L decreases to normal. This, again, is what it *should* do.

One writer claims that this swinging of the motor is caused by "centrifugal action." Another says it is due to "inertia" of the motor. Some say the belt tensions "are always the same," ignoring entirely the fact that the motor swings considerably around the hinge, continually decreasing and increasing the lever arm L. All of these explanations are incorrect. The true reason is very simple. It is merely a matter of applying the following elementary rules:

(a) Locate the center of gravity of the motor. In these sketches it has been assumed for convenience that the center of gravity coincides with the center of the shaft. In most motors, however, the center of gravity is between the base and the center of the shaft.

(b) Multiply the weight W of the motor in lb., by the distance L in in.; (L is the "lever arm" of the motor).

(c) Multiply the belt tension T in lb., by the distance H in in.; (T is the tension in the top belt and H is its lever arm).

(d) Multiply the tension B in lb., by the distance h in inches. (B is the tension in the bottom belt and h is its lever arm.)

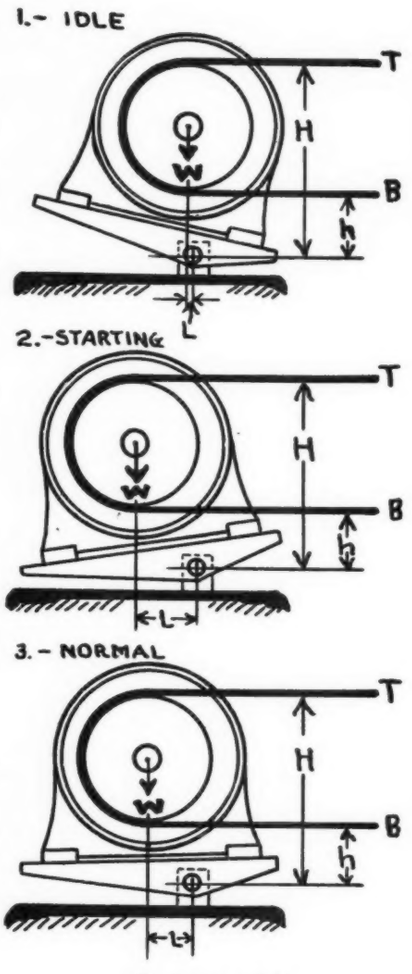
Now add (c) and (d). It will be found that in every position, 1, 2, and 3, the sum of (c) and (d) will always equal (b).

The above being an arithmetical truth, it is now easy to understand why the motor "backs into the belt." It is due to the fact that tensions T and B vary with the load. When idle, the tensions T and B are equal and T may be greater than it is at any other time. Since T has the greater lever arm, H, it naturally pulls the motor toward the right.

Next, when the motor starts, the tension B increases and T reduces. Often the tension T becomes almost zero; and what is more, the greater the movement of the motor toward the left the shorter h becomes, all of which is favorable to the production of the highest necessary tension B when starting.

Finally, after the load is up to speed and conditions become normal, the tension B automatically reduces and T increases. The increase in T and the advantage of its longer lever arm H pulls the motor back to normal running position. This is as it *should* be. The motor automatically does the *right thing* all the time.

Of course a simple case has purposely been chosen here in order to make everything clear. This is a bottom pull drive, and the belts (both top and bottom) are truly horizontal. However, regardless of whether the belt is bottom or top pull, and regardless of the direction of the belts, the same principles apply to any problem.



Figs. 1, 2, and 3

It is always possible to calculate arithmetically and foretell the exact action of the motor, knowing the weight and characteristics of the motor, and knowing the various lever arms, L, H, and h. There is nothing haphazard, mysterious, or difficult about it.

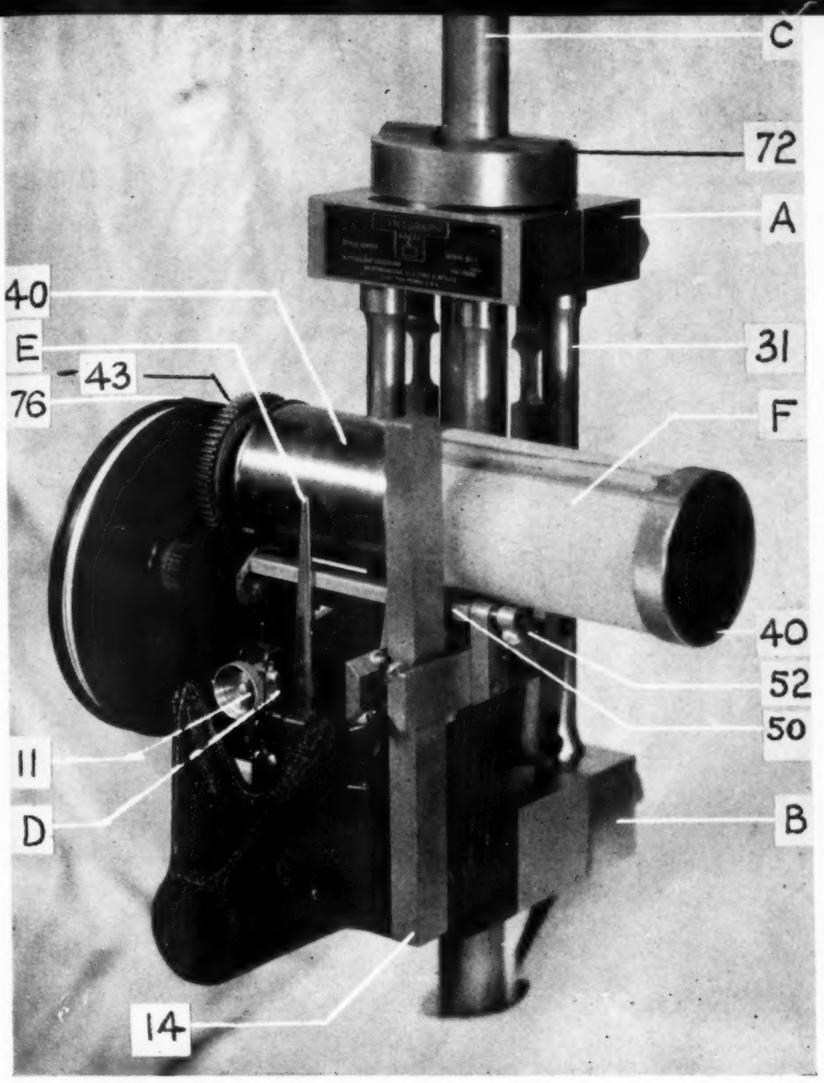


Fig. 1. Instrument on polished rod, showing how recording cylinder is removed

This new instrument—called the "Dynagraph" because it gives a graphic record of not only the load on, but the speed of, the polished rod throughout the entire pumping stroke—has been developed for greater accuracy in recording well loads

Oil Well Recording Dynamometer of New Design

By J. G. BAKER* and H. C. WERNER*

OIL well polished rod loads have been measured by several different means. In every case the load is obtained by indicating or recording the distortion or strain of an elastic member. The various schemes may be placed into two groups: (1) those in which the elastic member carries all the load, and (2) those in which the elastic member carries a load that is small compared to the well load but proportional to it. An example of apparatus of the second group is that in which a portion of the well load is placed on a diaphragm supported by water pressure. The water pressure is communicated by means of a long rubber tube to a steam engine indicator where a record like an indicator diagram is made (the elastic member in this case is the indicator spring). The difficulty with this arrangement is that friction and inertia effects of the water in the long rubber tube tend to introduce error in the load record when changes in well load occur. This type of difficulty is inherent in apparatus of the second group because it is difficult to make a mechanism for producing a proportional small load from a large load without considerable friction and inertia. For schemes of the first group only small distortion of the elastic member is permissible; first because large distortion would alter the well load by changing the motion cycle of the polished rod, and second because large distortion would necessitate large elastic-energy-storing capacity of the elastic member. The latter is a disadvantage in that the weight of an elastic member is roughly proportional to its elastic-energy capacity.

In view of the foregoing, the problem of measuring oilwell load practically reduces to the problem of measuring a small distortion of an elastic member carrying a large load. Several well-known electrical methods have been developed for this purpose. In the so-called magnetic strain gauge, the distortion to be measured moves an armature. Changes of reluctance in two magnetic circuits resulting from this movement unbalance a bridge circuit fed by high-frequency current.

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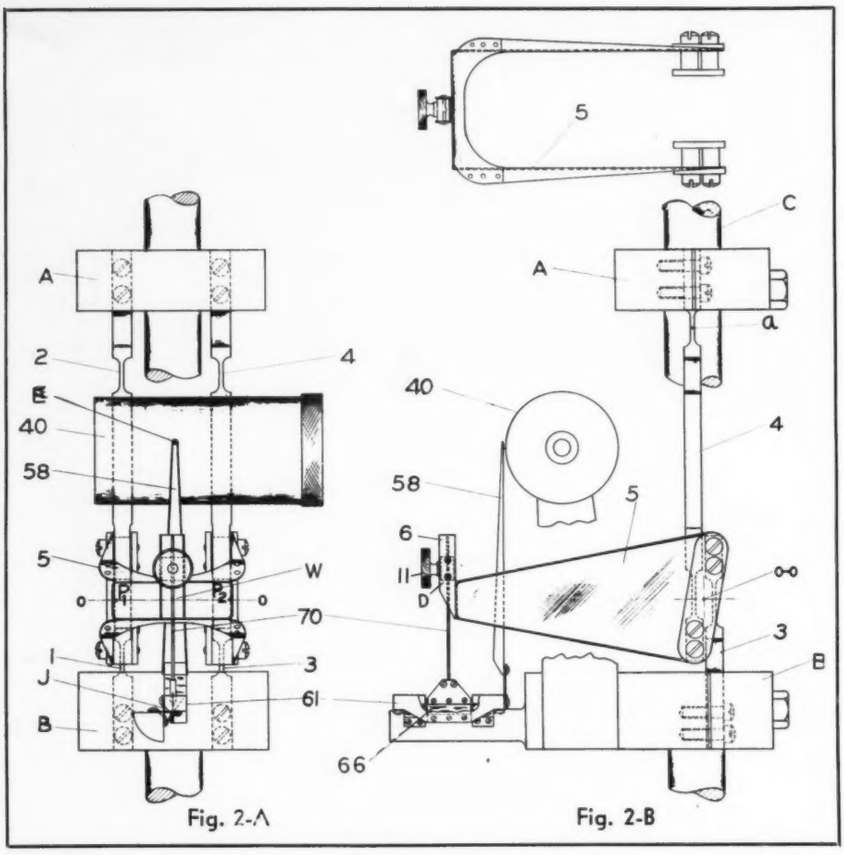


Fig. 2-A Fig. 2-B

Figs. 2-A and 2-B. Sketch showing details of Dynagraph

The voltage resulting from the unbalance of the bridge is rectified and recorded on an oscillograph. This scheme is objectionable for oilwell load recording because: (1) A change in the high-frequency source of voltage, a change in the reluctance circuit as might occur from rough handling, a change in the rectifier, which usually occurs with change of age or perhaps even with temperature, or a change in the oscillograph calibration will introduce an error in the record; (2) the apparatus is necessarily rather heavy, because power usually must be supplied by a storage battery through an M. G. set or oscillator; (3) since the record is made photographically, there is the inconvenience, delay, and expense of developing and handling of films. Despite these objections, if remote recording of strain is necessary this is doubtless the best method. Another electrical method uses a carbon pile resistance bridge. With this method only a direct current source of voltage is required. The oscillograph is still the means of recording. Hysteresis in the carbon piles and change in their pressure-resistance characteristics are some of the annoyances in the use of this scheme. In view of these objections to the electrical methods, it is natural to consider the use of simple mechanical means of indicating or recording the small distortions in question. A number of such devices have been used. The limitations of such devices have been either the errors due to bending of the polished rod, or the extent of the labor required to install the device on the well. The development of the mechanical load-recording apparatus described in this article was undertaken to avoid the objections just discussed, as well as to provide a practical means of recording the polished rod velocity. This apparatus, a recording dynamometer, is called the "Dynagraph" and has been developed by the Westinghouse Electric and Manufacturing Company. Entirely self-contained and its operation entirely mechanical, it weighs only 24 lb. and can be handled by one man. It may be used on the polished rod below the cross-arm or in compression above the cross-arm. It can be used on rods of any diameter

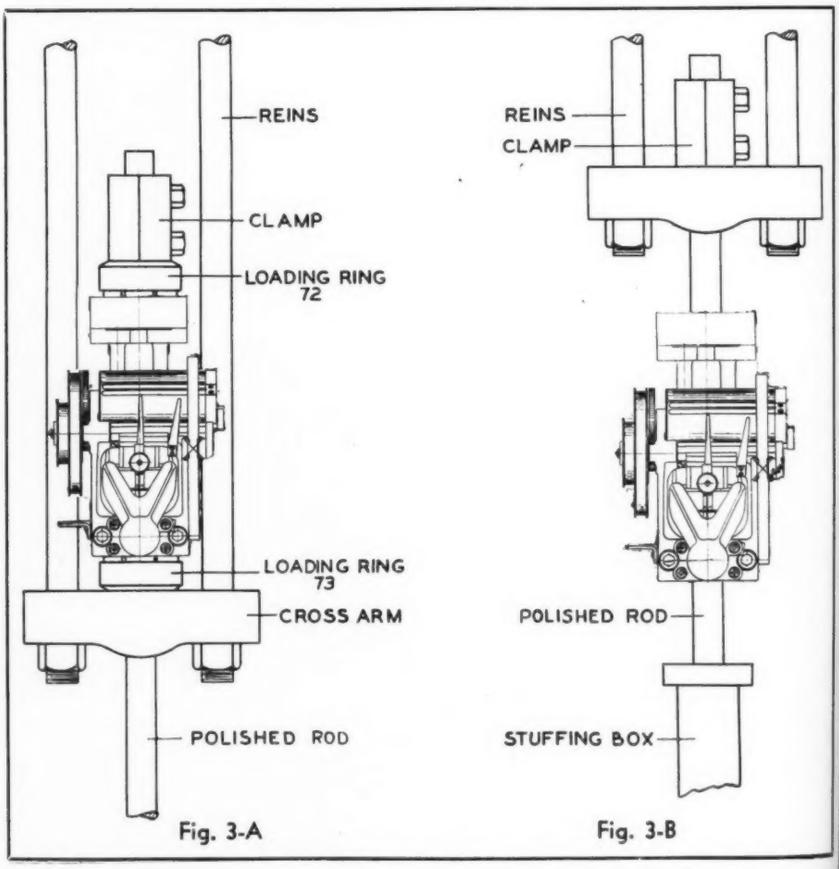


Fig. 3-A Fig. 3-B

Figs. 3-A and 3-B. Sketch showing how instrument may be mounted either above or below the cross-arm

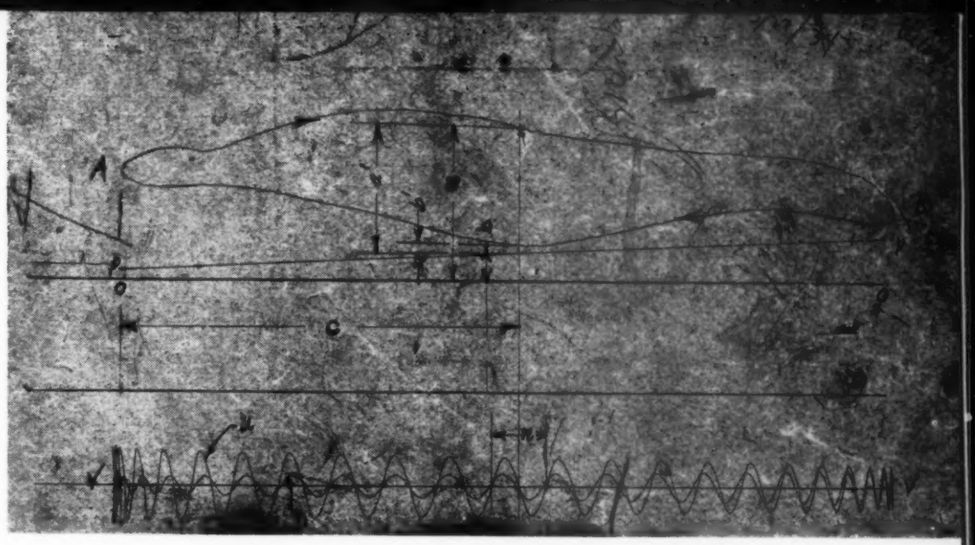


Fig. 4. Reproduction of an actual record made with the Dynagraph

from ¾ in. to 1¼ in. and on rods of any material of which the modulus of the elasticity is known.

From the record obtained there may be determined:

(1) The power required to pump the well.
(2) The maximum and minimum polished rod loads.
(3) The velocity and acceleration of the rod for any portion of the stroke.
(4) The strokes per minute.

Principle of Operation

No external source of power is required. Referring to Figs. 1, 2-A, 2-B, and 3-B, the two clamp assemblies A and B are mounted on the polished rod C. Load changes on C result in a stretch or strain between A and B. When A moves away from B the struts 1, 2, 3, and 4 produce a rotation of the U-beam, 5, about a horizontal axis. This rotation of 5 results in a vertical movement of the channel 6. This vertical movement is some ten times the extension between A and B. Thumbscrew holder 6 is attached by the connecting rod 70 and the thumbscrew assembly D to the recording stylus E. Stylus E moves horizontally some 40 times the vertical movement of 6. In short, the displacement of E is some 400 times the extension between A and B.

A string, wound around the pulley, 76, is held against some stationary point, the stuffing box of the well, for example. The movement of the polished rod up and down thus rotates the pulley, and also cylinder 40, by means of gears, 43. The record is made on waxed paper placed on the recording cylinder 40, which is removable only after all styli have been raised. The recording cylinder is easily removed while the well is in operation.

The four columns, 31, have clearance between them and the clamp assembly A and therefore do not normally function when the instrument is clamped on the polished rod. The purpose of 31 in this case is solely that of protecting the instrument if the well load is accidentally placed on it, in which case the clamps slip until they bear on columns 31. Only minor damage is done in this case.

Timing bar, 14, is spring-mounted on the frame of the instrument. To 14 is attached a stylus that also records on F. The constant frequency of the free oscillation of the spring-mounted timing bar 14 is utilized to produce a wave on the record to determine the velocity of the polished rod.

Various sizes of rods are accommodated by means of inserts placed into the main clamping members A and B.

The Use of the Instrument in Compression

In case there is not sufficient room on the polished rod between the cross-arm and the stuffing box, or in cases where the polished rod is badly worn, the instrument may be mounted above the cross-arm, as shown by Fig. 3-A.

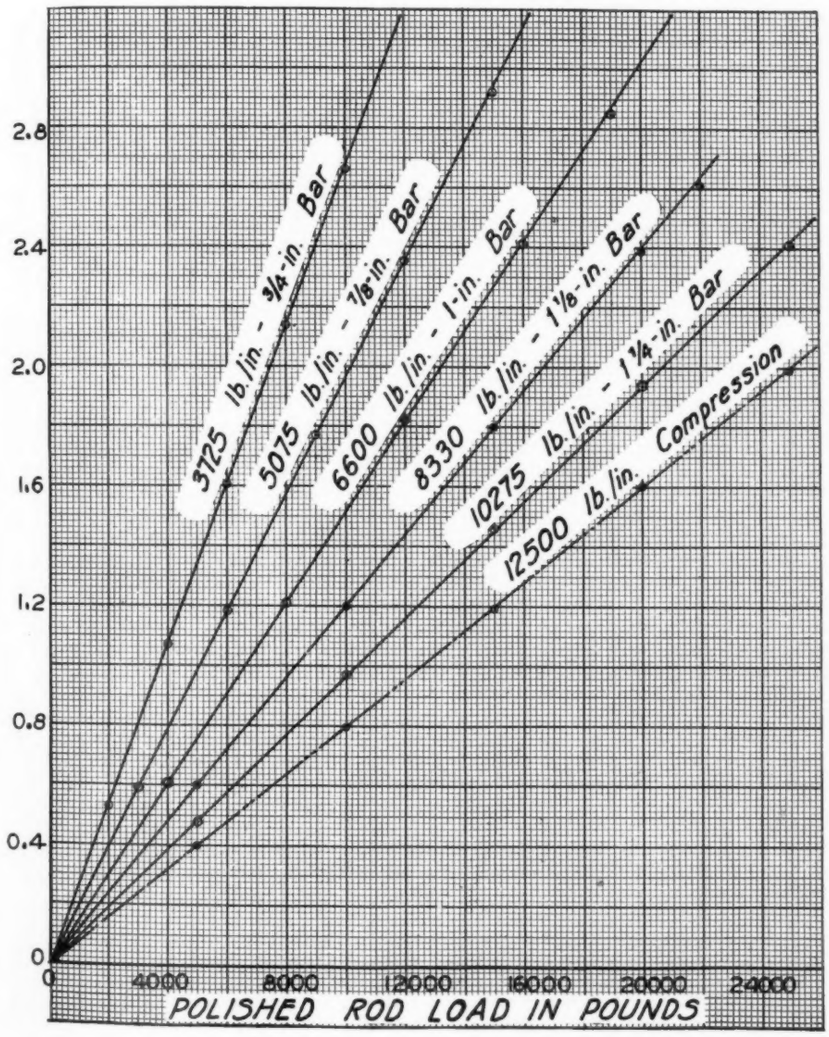


Fig. 5. Calibration curves showing the straight line characteristic of the instrument

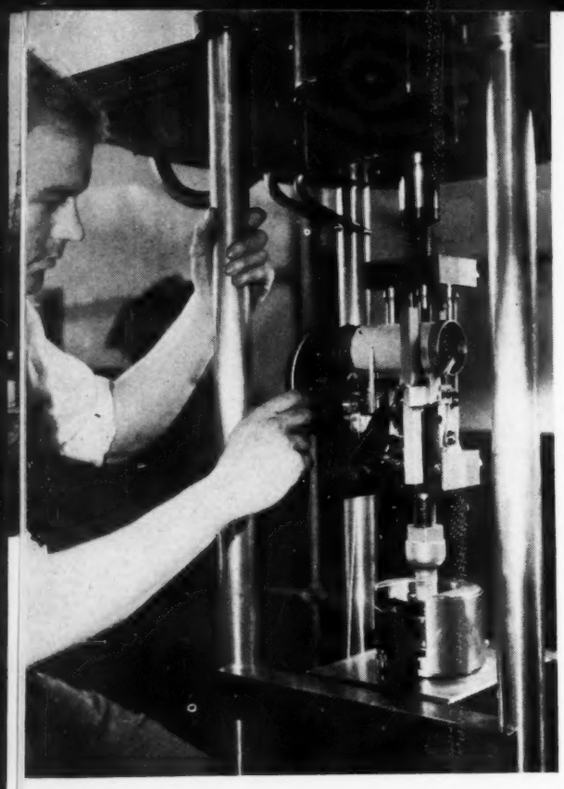


Fig. 6. Instrument under test in research laboratory

When the instrument is used in this way, it is bolted together as a solid unit. The columns 31 and clamp A are securely bolted together. The load is applied on the instrument by means of the polished rod clamp, normally used in pumping, which is moved up on the polished rod to accommodate the instrument. The polished rod clamp bears down on the load ring 72, which in turn loads the instrument in compression, the loading ring 73 taking the reaction at the bottom of the instrument on to the cross-arm.

Compression of the columns 31 causes elastic contraction, which is recorded on the drum.

Range of Application

The maximum stroke is 120 inches. A load of 25,000 lb. gives full scale deflection of 2½ in. with a 1¼-in. rod.

The instrument may be applied to ¾-in., ⅞-in., 1-in., 1⅛-in. and 1¼-in. diameter rods working at any angle. It can be used on rods of any structural material provided the modulus of elasticity is known, in which case the following formulae may be used:

$$\frac{\text{well load}}{\text{stylus deflection}} = K \times E \times D^2 \text{ lb. per in. deflection.}$$

Where K = the instrument constant.
E = the modulus of elasticity of the rod.
D = the diameter of the rod in inches.

Interpretation of Record

Fig. 4 shows a typical record. The load at any point in the stroke may be obtained by measuring the height of the diagram above the zero line (0-0) and multiplying by the proper constant. The constants for the instrument in compression and for the various sizes of rods are shown on a card in the case. The strokes per minute may be obtained from the timer record by counting the number of complete waves in one stroke, up *and* down. The power at the polished rod may be calculated from the record in a way similar to that used in calculating the power of a steam engine from an indicator card.

Discussion of the Design

By proper location of the necked-down portions of the struts 1, 2, 3, and 4 (Figs. 2-A, 2-B) and of the clamping points of the springs in the assembly J, a straight line calibration curve has been obtained. In Fig. 5 are shown the results of an actual test of an instrument in a testing machine. A straight line calibration is a convenience in that the load record may be interpreted with the use of a multiplication factor instead of by reference to a calibration curve.

Conditions for Zero Bending Error

Bending of the polished rod in the plane of Fig. 2-A, causing rotation of the clamp A clockwise, lowers the point P_2 and raises the point P_1 an equal amount. Thus the elevation of W does not change, the stylus E does not move, and therefore no error results. Bending of the polished rod in the plane of Fig. 2-B, causing rotation of the clamp A clockwise, bends the necked portions of the struts 2 and 4 at the point "a" (Fig. 3-B) and bends the struts 1, 2, 3, 4 at the elevation 0-0 but does not rotate the member 5 with respect to B, hence there is no motion at 6 and no error. For a large amount of bending of the polished rod C the lateral position of the struts 1, 2, 3, 4, the axial positions of the necked-down portions of the struts and the axial position of clamping the wire 70 at D are important. Tests on the instrument indicate that the bending error is less than one percent of the full scale deflection for bending stress as high as 15,000 lb./in.² on a 1¼-in. rod.

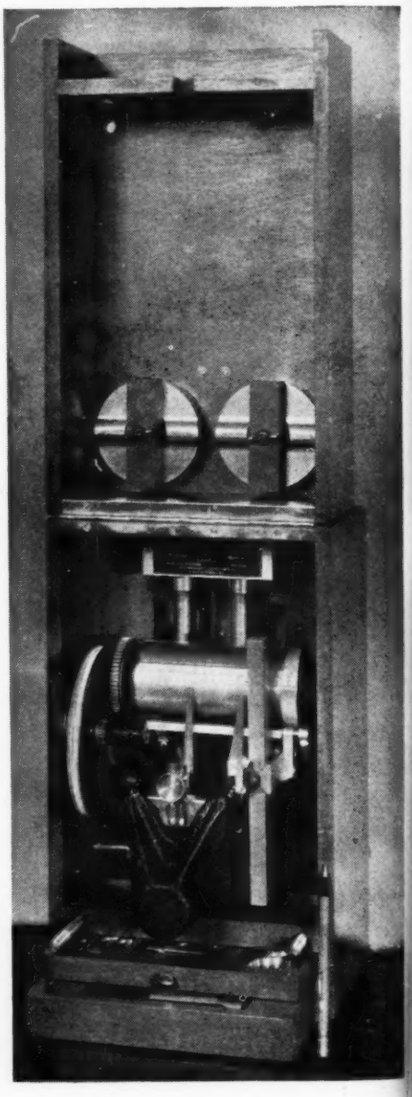
Errors Due to Sudden Changes in Load

The natural frequency of the instrument is about 80 cycles per second so that load changes up to 20 cycles per second are faithfully recorded. Higher frequency changes in load seldom occur.

Protection Against Accidental Loading of Instrument

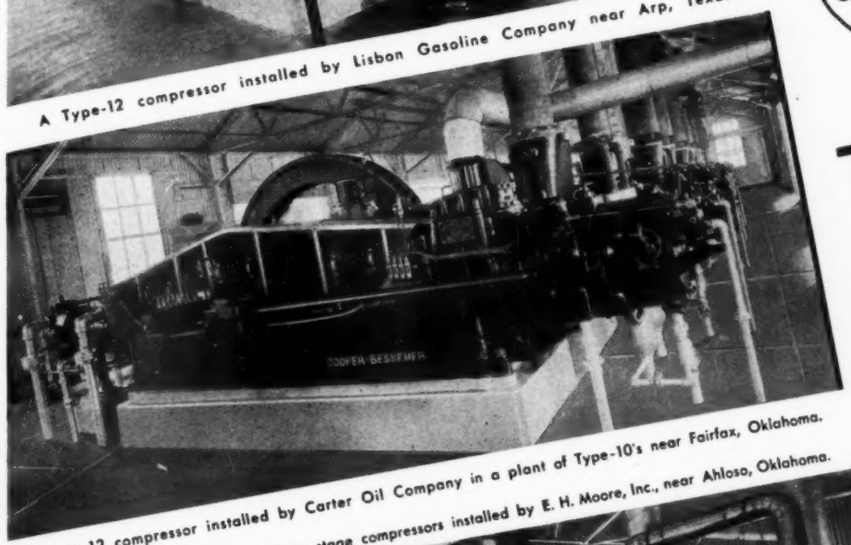
In case the well load is accidentally placed on the instrument when it is mounted on the polished rod below the cross-arm the clamps will slide toward each other until the clearance between the four columns 31 (Fig. 1) and the clamp A is taken up. This motion of the clamp results in more than one-quarter inch movement downward of the point W, Fig. 2-A. The recording stylus normally allows a movement of W less than one-tenth inch for full scale deflection. The extra deflection under accidental loading is taken by the buckling of the wire 70 and the breaking of the spring 66. The diameter of the wire 70 has been chosen small enough so that no damage to the stylus mechanism results. Replacement of 70 and 66 may be made without appreciably altering the calibration.

Fig. 7. Dynagraph and accessories complete with carrying case

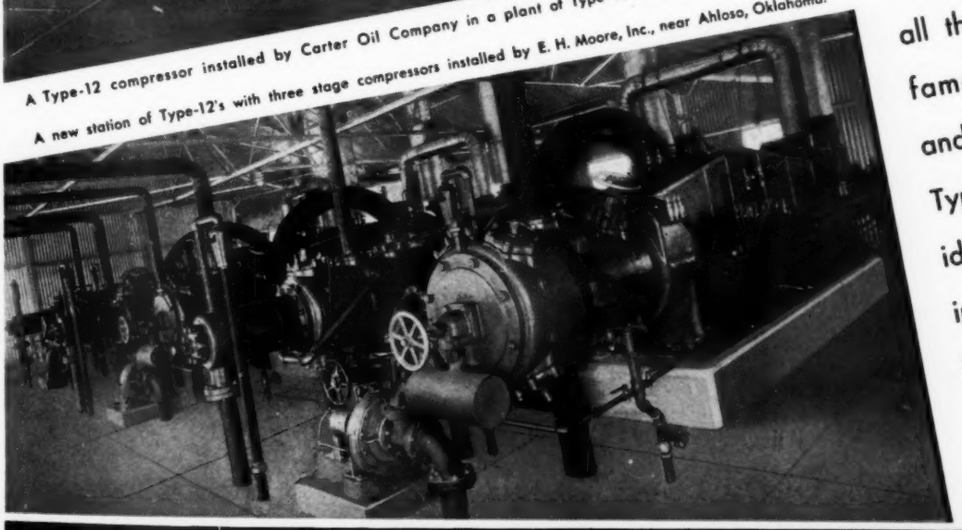


OVERHEARD in a Gasoline Plant

A Type-12 compressor installed by Lisbon Gasoline Company near Arp, Texas.



A Type-12 compressor installed by Carter Oil Company in a plant of Type-10's near Fairfax, Oklahoma.



A new station of Type-12's with three stage compressors installed by E. H. Moore, Inc., near Ahloso, Oklahoma.

THESE are the very words an operator used to express what he thought of the new Type-12 compressor unit. All we can add is it should be a good compressor because it combines all the best features of the famous Bessemer Type-10 and equally famous Cooper Type-80 plus all the new ideas we have accumulated in years of specialization in this field.

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Continuous Acid-Treating of Crude Oils for the Production of Motor Oils and Bright Stocks

By GEORGE M. WOODS

ABOUT the only batch refining operation that has not been displaced by continuous operations is the old time acid-treating procedure used on motor oils and bright stocks. Even this batch operation of acid-treating lubricating oils is being slowly but gradually replaced by the continuous acid-treating process that is carried out in the presence of propane. Another continuous process for treating lubricating oil involves continuous acid-treating followed by centrifuging for removing the sludge from the treated oil, but it is doubtful if this process will ever become extensively employed by the refining industry.

Another continuous acid-treating method that may be used for lubricating oil production is to acid-treat the crude oil in a regular cracked naphtha continuous acid-treating unit. The principle of the continuous acid-treating cracked naphtha unit is well known and needs no discussion here. These units have been used extensively in the past, but their use for treating cracked naphtha is rapidly declining because of the wide marketing of dyed and inhibited gasoline. Many of the more progressive refiners have found that by the use of dyes and inhibitors their cracked gasoline may be disposed of without resorting to the acid-treating and rerunning operations. In this manner substantial chemical and processing costs are saved.

Laboratory work was undertaken in order to compare the method of finishing lubricating oils by the continuous acid-treating crude oil procedure with the usual refining procedure of finishing lubricating oils by batch acid-treating. It was found that the continuous acid-treating of the crude oil offered a ready means of processing lubricating oils and bright stocks at a substantial reduction in chemical and processing costs. In addition it was found that some residual stocks that could not be used for the production of bright stocks because of the large amount of asphaltic material they contained could easily be processed by the crude oil treating procedure. The details and results of the laboratory investigation carried out on this problem, on which the preceding conclusions are reached, are given in the following paragraphs.

Two representative crude oils were obtained for this investigation. One was a typical Mid-Continent paraffin base crude oil that is currently used for the production of lubricating oil and bright stocks, while the other represented a paraffin base highly asphaltic crude oil from the Texas Panhandle area, that was suitable for producing overhead lubricating oil but not bright stock, because of the large amount of asphaltic material present in the crude residual. Inspection data on these two crude oils are given in Table I.

TABLE I

Inspection Data on Crude Oils

Crude Oil	Mid-Continent Crude Oil	Texas Panhandle Crude Oil
Gravity, deg. A.P.I.	43.1	38.9
Color	Light Green	Dark Green
Viscosity at 100 deg. fahr.	42.5	45.5

Portions of each of the crude oils were given acid treats using 98 percent sulphuric acid with a mixing time of three minutes. During this time the crude oil and acid were well mixed together. The mixture was then allowed to settle one hour, the sludge withdrawn and the acid oil transferred to a clean mixer where it was water-washed and caustic-neutralized. The Mid-Continent crude oil was treated with five lb. of acid per bbl. of oil while the Texas Panhandle crude oil was treated with ten lb. per bbl. of acid. The sludge loss in the case of the Mid-Continent crude oil was 2.3 percent, while on the Texas Panhandle crude oil the loss amounted to 3.7 percent. These losses are based on the quantity of crude oil charged and the increase in acid volume due to treating. The neutralization value was determined on each of the acid-treated and caustic-washed crude oils and was found to be 0.16 and 0.13 respectively, on the Mid-Continent and Texas Panhandle treated crude oils. Each of these treated crude oils was charged to a still along with the theoretical amount of caustic and reduced to the gas-oil range by means of fire and steam. The reduced crudes were then further distilled under vacuum to a still temperature of 635 deg. fahr., the overhead cuts being taken in one percent fractions. The bottoms amounted to 11.2 percent on the Mid-Continent crude while on the Texas Panhandle crude oil the bottoms amounted to 17.1 percent. The overhead lube oil cuts from each of the treated crude oils were blended in order to produce a 50-viscosity at 210 deg. fahr. waxy stock. The yield of waxy lube oil amounted to 6.3 percent on the Mid-Continent stock and 8.2 percent on the Texas Panhandle stock. All the above yields are based back on the original untreated crude oil, and not on the acid-treated and neutralized crude oil. The two overhead oils and the two residual oils were fluxed with secondary butyl acetate in the ratio of three parts of flux to one part waxy oil. These solutions were chilled to -10 deg. fahr. and filtered through filter paper using vacuum. After filtering, the solutions were stripped of the flux by means of distillation. The dewaxed oils were then contacted to color with Filtrol clay. The contacting conditions on the four oils being:

Crude Source	Mid-Continent		Texas Panhandle	
Stock	Motor Oil	Bright Stock	Motor Oil	Bright Stock
Clay Used, lb./gal.	0.10	0.25	0.10	0.50
Contacting Temperature, deg. fahr.	400	500	400	500
Contacting Time, hrs.	1.0	1.5	1.0	1.5

Inspection and yield data on the finished oils and bright stocks produced from the acid treated crude oils are given in Table II.

For comparative purposes the two

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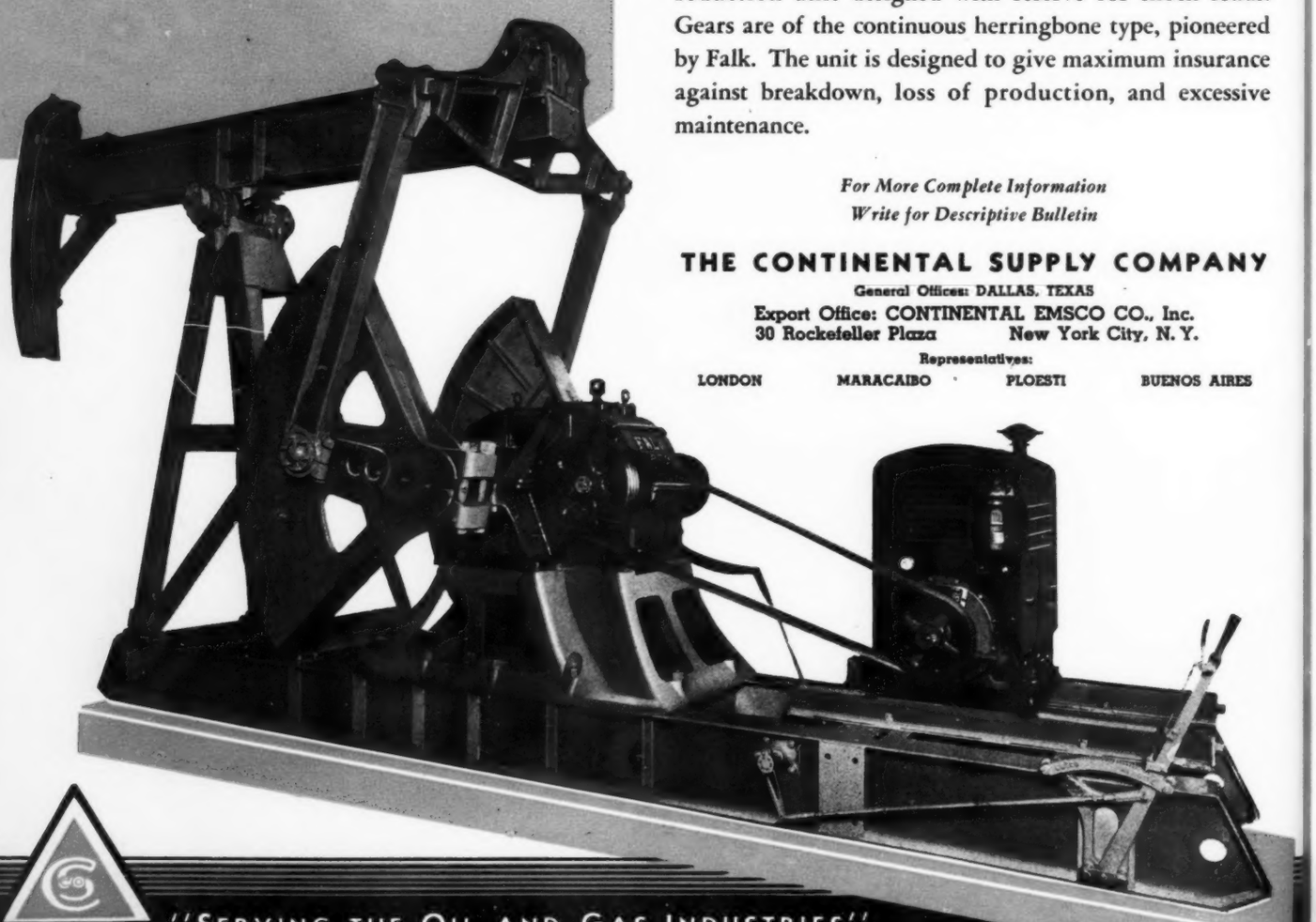

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CONTINENTAL

crudes were worked up in the laboratory for lube oil and bright stock in the conventional manner. The Mid-Continent crude was reduced to 13.0 percent bottoms, the lube oil cuts taken off under vacuum amounted to 7.2 percent of the crude oil. The Texas Panhandle lube oil cut amounted to 10.6 percent and the bottoms stock to 20.4 percent of the crude oil. The Texas Panhandle residual stock could not be acid-treated in the conventional manner because of the large amount of asphaltic material it contained. It could, however, probably be treated in propane solution. The Mid-Continent residual stock was given an acid treat of 35 lb. of 98 percent acid per bbl. at 140 deg. fahr., the treating loss amounted to 32 percent. The acid oil was contacted with 0.25 lb./gal. of Filtrol clay. This contacted residual stock and the two overhead motor oil cuts were dewaxed by the secondary butyl acetate method as outlined above. After dewaxing and removal of the solvent the motor oils were each given an acid treat of 20 lb. of 98 percent acid per bbl. of oil, the treating loss being in each case 17 percent of the oil charged to the acid-treating step. The three oils were then contacted under the following conditions:

Crude Source	Mid-Continent		Texas Panhandle
Stock	Motor Oil	Bright Stock	Motor Oil
Clay Used, lb./gal.	0.50	0.75	0.50
Contacting Temperature, deg. fahr.	400	500	400
Contacting Time, hrs.	1.0	1.5	1.0

Inspection and yield data on the above three oils are given in Table II.

The experimental results indicate that substantial savings in chemical costs (acid and clay) may be obtained by the total crude oil acid-treating procedure. A greater advantage of the crude oil acid-treating procedure, however, lies in the fact that this method can be used to process crudes for bright stock that are impossible to process by the conventional batch-treating method. It will be noticed that a bright stock of Pennsylvania quality (99 viscosity index) was prepared from Texas Panhandle crude oil by the crude oil acid-treating procedure. An even greater possibility for the crude oil treating procedure, is with those refiners that have continuous acid-treating cracked naphtha treaters that are no longer needed in that service. Such treaters could easily be used for continuous crude oil acid-treating. No attempt has been made toward an economic analysis of this problem, because the conditions of each refiner is different; but it is believed that the crude oil acid-treating process for the finishing of motor oils and bright stocks has possibilities that warrant immediate adoption under certain conditions.

TABLE II

Comparison of Conventional Finishing Method and Crude Oil Treating Method for Producing Motor Oils and Bright Stocks

Treating Method	CRUDE OIL METHOD				CONVENTIONAL METHOD			
Crude Source	Mid-Continent		Texas Panhandle		Mid-Continent		Texas Panhandle	
Grade of Oil	Motor Oil	Bright Stock	Motor Oil	Bright Stock	Motor Oil	Bright Stock	Motor Oil	Bright Stock
Yield of Finished Oil, % of Crude[1]	4.69	8.33	6.10	12.74	4.45	6.29	6.55	....
Lb. acid used/bbl. crude	1.00[2]	4.00[2]	1.00[2]	9.00[2]	1.15	4.55	1.70	....
Lb. clay used/bbl. crude	0.21	0.94	0.28	1.84	0.99	2.87	1.47	....
Gravity, deg. A.P.I.	29.2	26.7	30.1	26.3	29.0	25.9	30.3	....
Flash, deg. F.	425	500	435	505	420	555	435	....
Viscosity at 100 deg. F.	406	3250	371	2024	374	3150	383	....
Viscosity at 210 deg. F.	56.2	165.7	55.5	160.3	54.9	162.1	56.1	....
Viscosity Index	84	88	92	99	85	88	91	....
Color, Robinson	9½	1½—	9+	1¼	9¼	1¼+	8¾—	....
Pour Point, deg. F.	0	5	0	5	0	5	5	....
Carbon, %	0.05	1.64	0.08	1.84	0.04	1.73	0.09	....

[1]Contacting loss assumed to be 7 percent and the dewaxing loss 20 percent of the oil treated.
[2]Total of five lb. used on each barrel of crude.
[3]Total of ten lb. used on each barrel of crude oil.

Boiler Feed Water

FOUR interesting technical papers and the reports of two committees featured the fifth session of the A.S.T.M. meeting devoted to water—the session having been arranged under the joint auspices of A.S.T.M. Committee D-19 on Water for Industrial Uses and the Joint Research Committee on Boiler Feed Water Studies.

Two of the technical papers were prepared in connection with investigations conducted under a cooperative agreement between the Joint Research Committee and the U. S. Bureau of Mines; Messrs. Schroeder, Berk and Partridge prepared the papers. In the one entitled "The Use of Solubility Data to Control the Deposition of Sodium Sulfate or its Complex Salts in Boiler Waters," it is pointed out that the constituents of a boiler water are believed to exert an important effect upon the cracking of boiler steel —for example sodium silicate and sodium hydroxide tend to produce embrittlement and sodium sulphate tends to inhibit this effect.

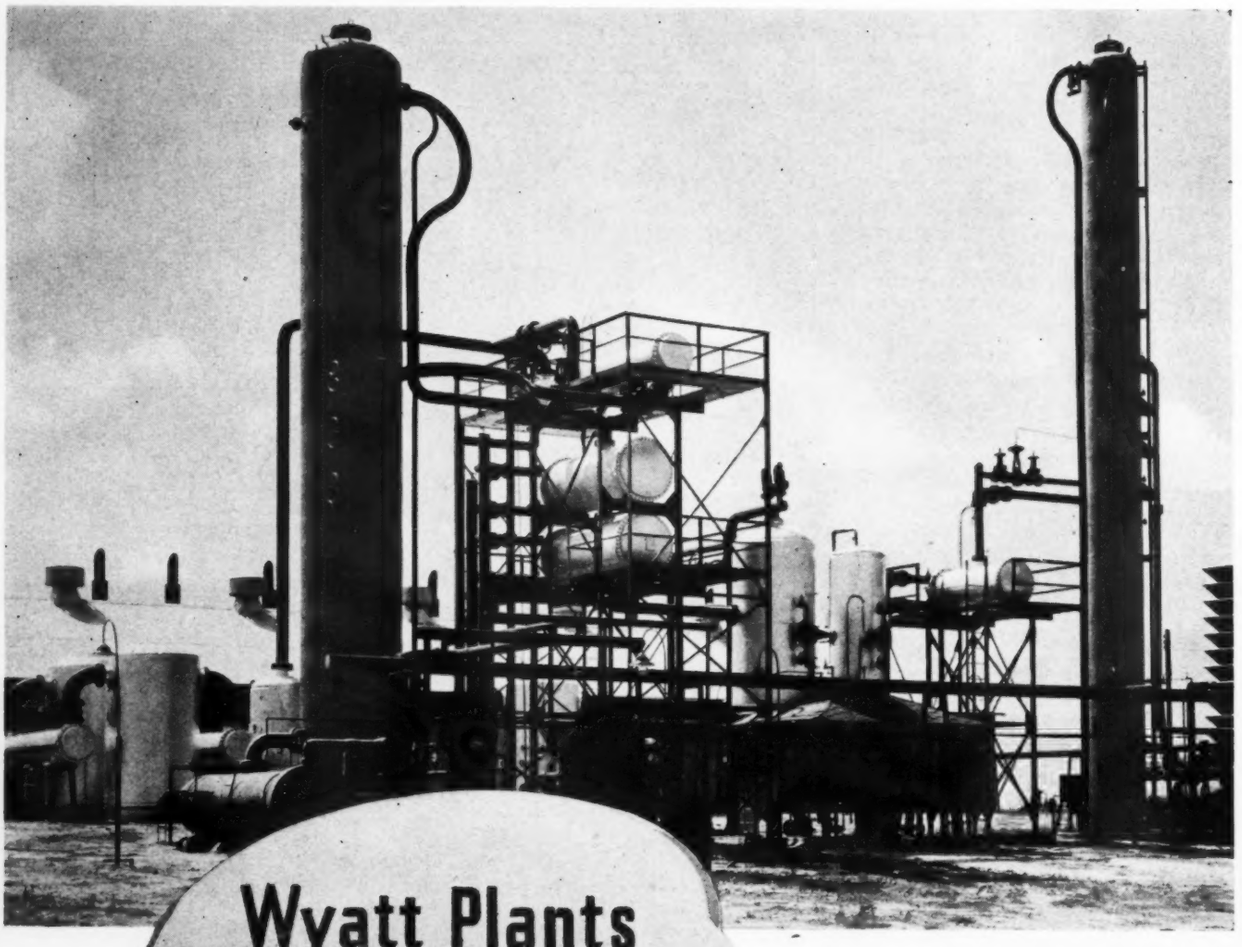
The other paper by the same authors on "Effect of Solution Composition on the Failure of Boiler Steel Under Static Stress at 250 Centigrade" details an investigation primarily directed to obtain information concerning the chemical factors involved in the production and prevention of embrittlement in boiler steel.

It is indicated that pure sodium hydroxide has little effect on the load that a steel specimen will carry, but if the specimen has a line of stress concentration, such as a groove, sodium hydroxide definitely decreases the load-carrying ability.

An investigation on "The Rate of Reaction of Sodium Sulfite with Oxygen Dissolved in Water" reported by Messrs. Hitchens and Towne, Monsanto Chemical Company, St. Louis, Missouri, shows that the reaction rate is a function first of the type of water, second of the temperature, and third of the excess of the reagent employed.

Among the conclusions reached in the paper on "Determination of Dissolved Oxygen in Boiler Feed Water" by Prof. A. H. White and Messrs. Leland and Button of the University of Michigan—the paper being a progress report of work under the auspices of the Joint Boiler Feed Water Committee, is that the direct Winkler method for determining dissolved oxygen may have an accuracy of 0.001 ml. of oxygen in the volume titrated, if there are no interfering substances and the end point is determined electrometrically. Non-volatile interfering substances may be removed by boiling off the dissolved oxygen and collecting it again in distilled water where it is determined by the Winkler method. The oxygen from a 1-liter sample may thus be concentrated to one-tenth of that volume and titrated in a solution freed from all but volatile impurities. Corrections for oxygen introduced with the reagents and for oxidation during exposure are small and capable of accurate determination and the method is indicated as being theoretically sound and free from systematic errors.

Refinery and Natural Gas



Wyatt-equipped natural gasoline plant built by Petroleum Engineering, Inc., near Kilgore, Texas.

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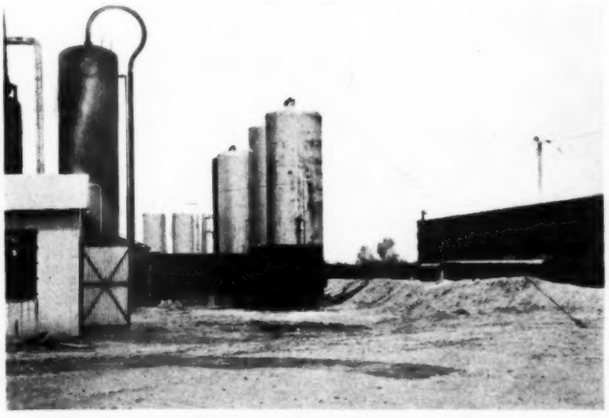
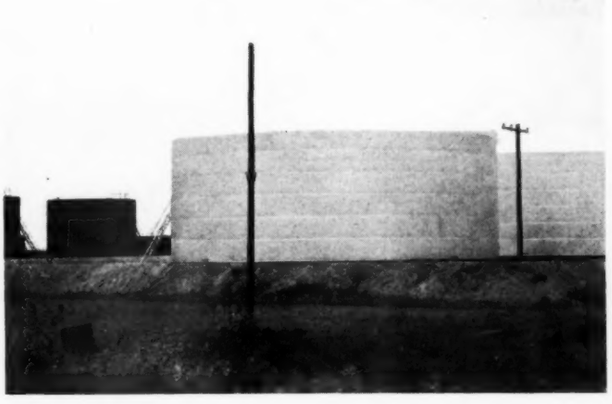
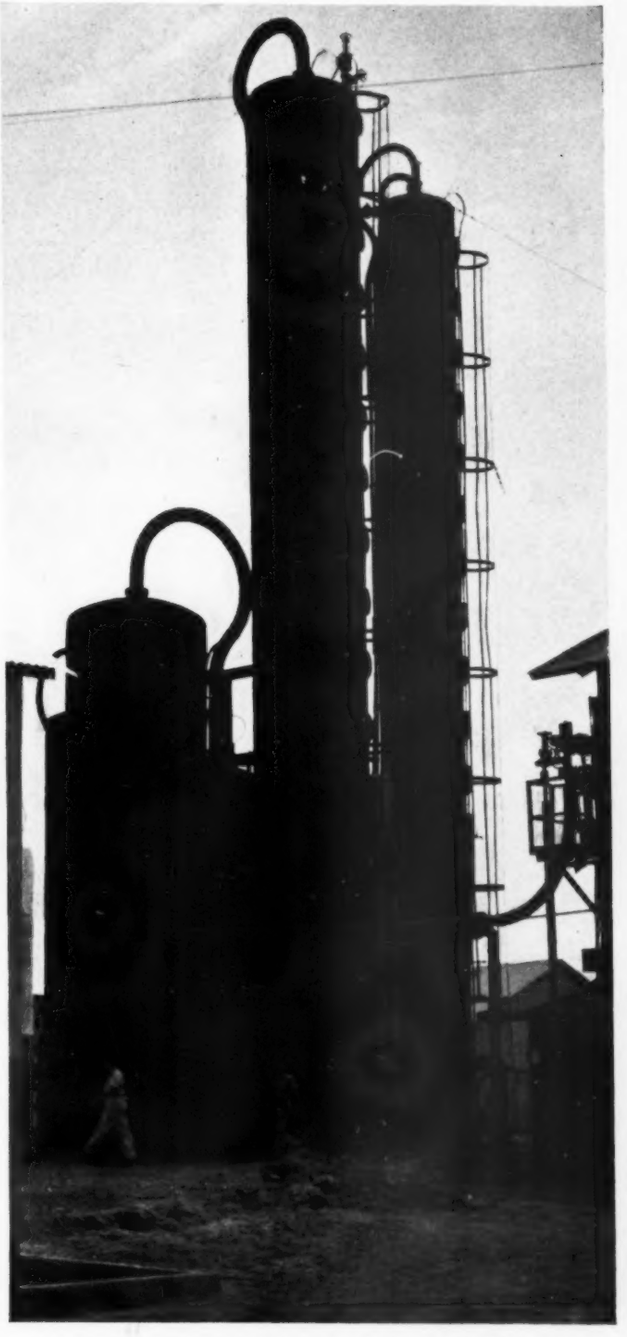


Cooling tower on right, part of control house on left, and part of distillation and treating equipment in the background, Port Isabel Refinery of Coastal Refineries, Inc.



View showing part of the tankage; three 55,000-bbl. tanks, comprising part of the 265,000-bbl. storage. Port Isabel Refinery, Coastal Refineries, Inc.

The experience of the Wyatt organization is invaluable to engineers and refiners who look for intelligent cooperation from their supply source in providing equipment to meet the exacting requirements of modern distillation engineering.



Bubble towers and flash chambers, Port Isabel Refinery, Coastal Refineries, Inc.

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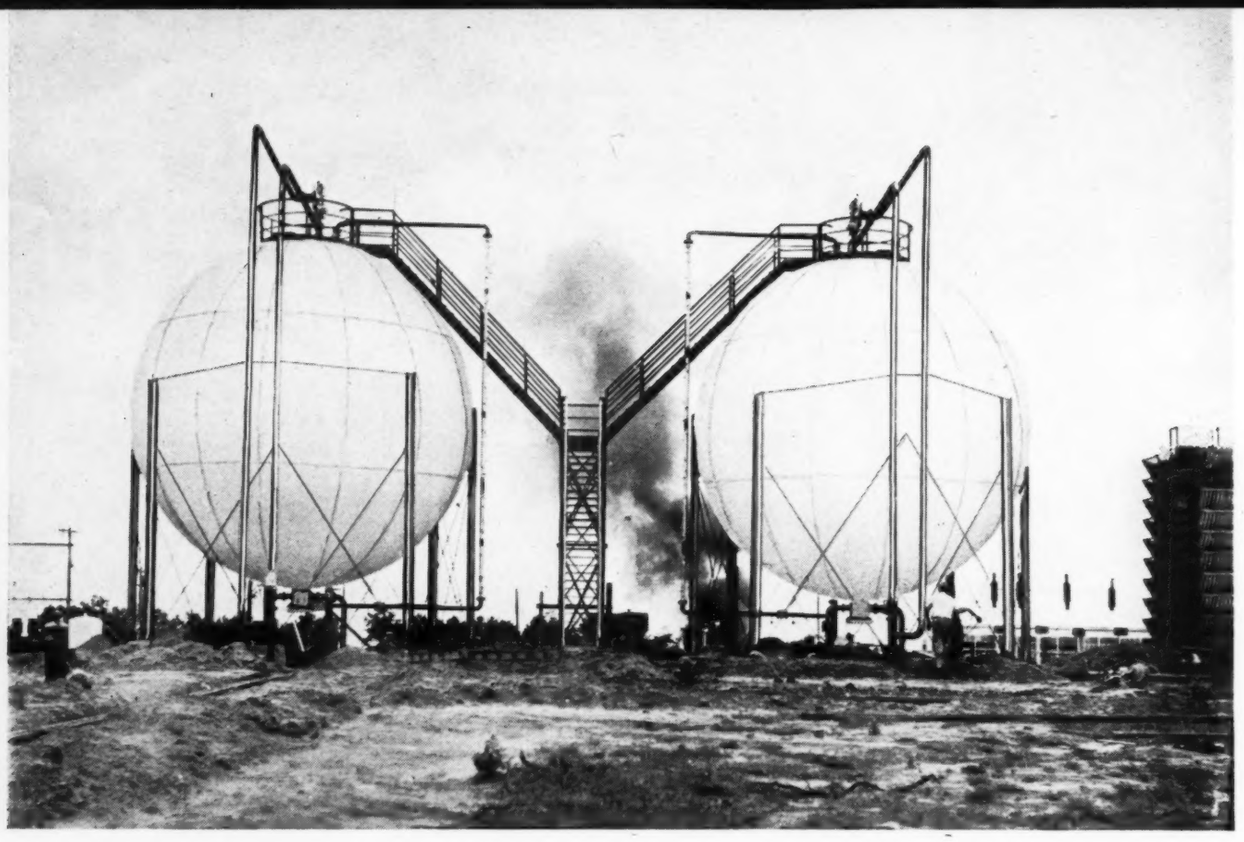


Two spherical stock tanks, each of 2500-bbl. capacity, have been constructed for 100-lb. working pressure

Construction Features New Gaso l

By FRANK H. LOVE

First line of its kind laid entirely within the boundaries of the state of Texas, it has presented certain construction problems characteristic of gasoline lines—One pumping station erected—Capacity of line 9000 barrels.

THE 300-mile 8-in. pipe line of the Humble Pipe Line Company, extending from the East Texas field to Baytown, that has been under construction over a period of approximately five months, is now in operation. The line, used for the transportation of natural gasoline, butanes, and propane, follows the route of the Humble's oil line via Groesbeck, Hearne, and Webster to Baytown, and is the only one of its kind laid entirely within the boundaries of the state of Texas.

Certain portions of the line were constructed of new pipe, other sections being of reconditioned stock. Wherever possible, too, the old oil line was made to serve as a part of the new system. Frequently when a section of the oil line was thus removed from its previous service it was necessary to lay loops in order that the oil transportation system not be impaired.

With one pumping station erected at London in the East Texas field the capacity of the line is 9000 bbl. of gasoline per day. There is the possibility of an intermediate station being built at Hearne later, and if and when this is done the capacity will be increased to approximately 12,500 bbl. per day. The station at London is situated near the Humble's large natural gasoline plant and it is from the latter that a large part of products transported is obtained. In addition, natural gasoline, butanes, and propane are being taken from other plants in the area, notably from Hanlon-Buchanan, Inc. At its Baytown refinery the Humble Oil and Refining Company is installing a polymerization plant as a part of the project.

Construction of the line and erection of the pumping station involved a number of interesting features. In converting portions of the crude system into a gasoline line, inasmuch as considerable of the old line was of screw and coupled joints, it was necessary to uncover the collars and weld them. Both electric and acetylene types of welding were employed throughout the construction.

All old pipe used in the line first was reconditioned. In instances where the existing crude oil line was to be used, and it was to remain in its original trench, the pipe was uncovered, raised above the ditch and placed on skids, then a travelling type cleaning machine was run down its length. All pipe, new as well as reconditioned, was treated with a primer, two coats of hot Ennjay enamel, and wrapped with asbestos felt. Pipe that had to withstand considerable handling, such as new pipe and shipped in reconditioned stock, was wrapped with kraft paper in addition, this for the protection of the coatings. Used pipe shipped in came in 40-45 ft. sections and was cleaned with a stationary type machine. The machine employed in this instance was

Station building in which are housed the two 300-hp. convertible gas engines driving 8-stage centrifugal pumps through speed increasers; as well as other auxiliary equipment

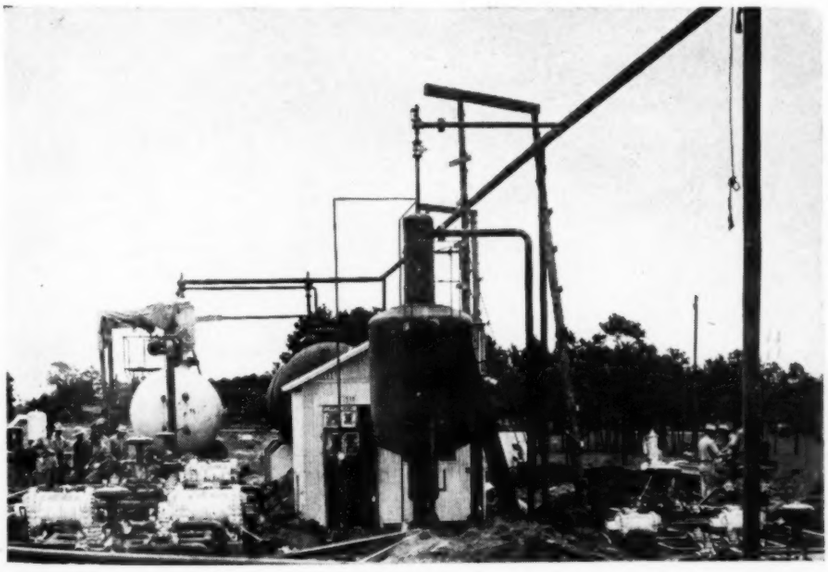
o line Line, East Texas to Baytown

equipped with 360 cutters, as well as revolving brushes, and could be adjusted to handle any size pipe from 2 in. to 14 in. in diameter. Cleaning and priming was done in one operation. Another machine applied the two coats of enamel, the asbestos felt, and the paper wrapping, also done in one operation. New pipe was handled in the same manner, except that it was not cleaned. Instead the primer was applied with a spray gun, the remainder of the procedure being identical with that employed for used pipe.

Few difficulties were encountered in the laying of the line and, for the most part, only conventional pipe line practices were required. The country traversed was of a rolling nature, the soil a sandy loam, and ditching was easily accomplished, a trench of approximately 24 in. in width and 30 in. in depth being cut. The difficulty of clearing the right-of-way was eliminated, since the new line was laid along the same route as that of the old crude oil line. Several river crossings were made and here the strings of pipe, after being made up and heavily weighted with river clamps, were pulled into place by tractors and tied in on either bank. Gate valves were placed approximately every ten miles, the distance varying, their location being determined by the accessibility to roads, topography, etc.

The nature of the products transported by a gasoline pipe line naturally makes it more than ordinarily necessary that each foot of the pipe line be thoroughly tested for leaks. Consequently, as each section of the line was completed, it was given a hydrostatic test of approximately 700 lb., the pressure being allowed to remain for a period of 12 to 24 hours, to make certain of revealing all faulty welds, bad spots in the pipe, etc.

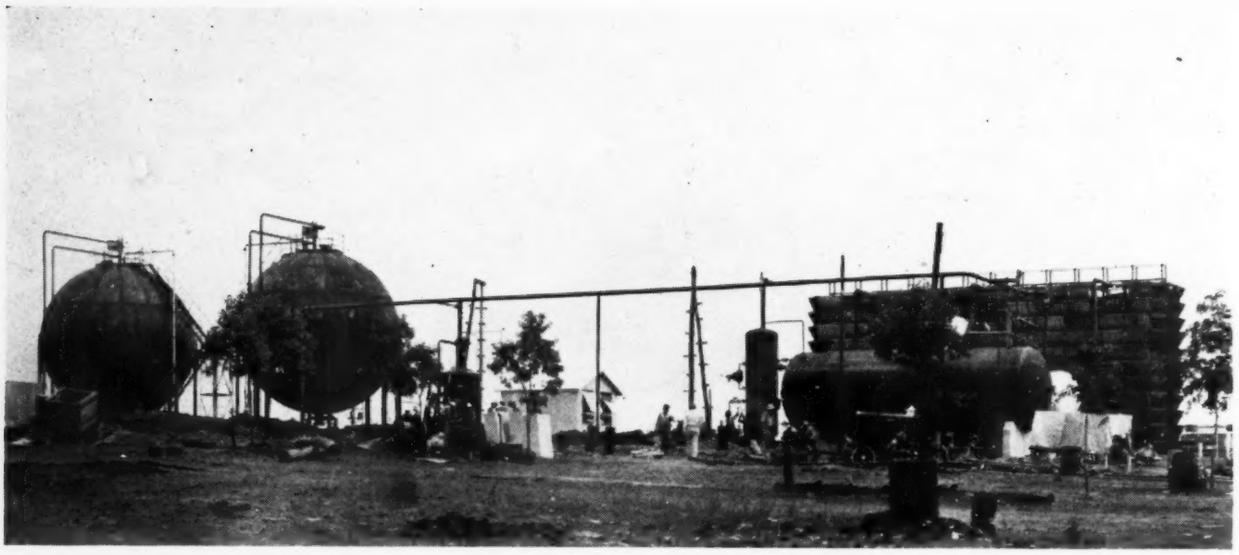
Another precautionary measure necessary was the elimination of conditions likely to result in contamination of the products handled through the system. To solve this problem a process was evolved for cleaning the inside of the line. The procedure was as follows: Approximately 25,000 bbl. of kerosene distillate was stored in tankage in the East Texas field in the vicinity of the London pumping station, with an equal amount stored at the Humble Oil and Refining Company's Baytown refinery. The line first was displaced with water. Scrapers were then started at Baytown and pumped through to Hearne. The water was followed by a caustic solution, which, in turn, was followed by kerosene, scrapers being inserted in the line at stipulated intervals. At Hearne a tank was reserved for receiving the kerosene from Baytown. A similar procedure was employed on the section of the line between London and Hearne, drawing upon the stocks of kerosene at London.



This photograph shows the meter house, displacement meters, calibration tank for checking the latter, and (in the background) the settling tanks

LONDON PUMPING STATION

The pumping station at London has as its equipment two 300-hp. convertible gas engines driving 8-stage centrifugal pumps through speed increasers. One engine is utilized for maintaining line capacity, with the other as a standby. There also are two spherical stock tanks, each of 2500-bbl. capacity, constructed for 100-lb. working pressure. These are employed for receiving the gasoline and casinghead mixtures from



General view showing spherical stock tanks, metering equipment, settling tanks, cooling tower, etc.

the field through displacement meters that measure capacities. In addition, the equipment includes pressure gauges, settling tanks, etc. All equipment is so arranged that a back pressure can be maintained on the entire system, including suction of the pumps, of a range sufficient to insure that the product handled is in liquid form at all times.

Gasoline enters the station from the field through an 8-in. line and a 4-in. line. The stream from the north is received through the 8-in., entering through a reducing regulator that maintains an even flow at a constant pressure before going to an 8-ft. by 30-ft. horizontal settling tank. It is discharged from this tank through a flow meter, then passes through a 4-in. high-pressure displacement meter, to a second 4-in. meter, thence into the spherical stock tanks. The liquid level is maintained in the settling tank by means of a liquid level controller placed in a dome on top of the tank, controlling inlet and outlet gases. Situated close to the settling tank is a 10-ft. by 30-ft. horizontal safety tank. The flow of gasoline from the south, entering the station through a 4-in. line, is much the same as that just described, except the settling tank used for this stream is a vertical one and the high-pressure meters are 2-inch.

Within the meter house are two vapor-pressure recorders, one for each stream, an equal number of pressure temperature recorders, and one flow meter. Immediately outside the meter house is a calibration tank for checking the displacement meters.

The fill lines to the spherical tanks and the suction lines to the pumps are tied together in such a manner that by opening a valve it is possible to pump over and short. The spherical stock tanks are of all-welded construction, built for a working pressure of 100 lb. and were tested at a water pressure of 150 lb. prior to being put into use. Each tank is equipped with two 4-in. relief valves set at 95-100 lb. pressure, plus a safety head set to break at a pressure between 140 and 150 pounds. In addition each has a gauge column with high-pressure pyrex gauge glass; as well as dial thermometers (three on each tank) that make it possible to determine the temperature at any desired depth within the tank. Readings are taken from instruments mounted on a steel instrument board situated on top of the tanks. The 6-in. fill line and the 8-in. suction line are tied in at the bottom of the tanks, and the latter is equipped with connections for a booster pump should one be needed at a future date. Between the spherical tanks and the pumps strainers have been placed to remove all foreign matter from the gasoline. As a safety measure the spherical tanks, settling tanks, and the calibration tank are all tied into a dump line. This line leads to a sump some distance from the plant and in event any of the tanks "pop" the overflow is carried off and automatically ignited by a pilot light.

At the lower end of the station grounds, slightly down-grade, is situated the pump house, a structure with galvanized iron covering, in which is housed the engines and pumps. The two 300-hp., 6-cylinder, convertible gas engines have a rated speed of 400 r.p.m. and are connected through a brick firewall with 24 by 10 centrifugal pumps, the latter driven through speed increasers at a ratio of 9 to 1. All units are set on concrete foundations. Cooling water gravitates from the cooling tower to the engines, and, after circulating through the engine jackets, is picked up by a rotary pump and discharged back to the tower for the beginning of a new cycle. Lubricating oil is reclaimed by a centrifuge situated in one corner of the main pump room. Each of the engines also is equipped with an air cleaner. Starting air is supplied by a two-stage air compressor having a 4-in. stroke and a bore of 4½ in. on the low-pressure side and 1⅞ in. on the high-pressure side.

One phase of the operating practice at the station calls for the circulation of mineral seal through the packing glands of the pumps to absorb any leakage of gases or gasoline. The procedure serves also as a means of cooling the packing. The mineral seal oil is obtained from the Humble's London gasoline plant, and after becoming saturated with gases, it is returned to the plant and a fresh supply obtained.

The Oklahoma Contracting Company, Dallas, Texas, had the contract for a part of the line, the remainder being laid by crews of the Humble Pipe Line Company. Mayes Brothers, Houston, Texas, were in charge of coating and wrapping a portion of the reconditioned pipe, as well as the new stock.

Care and Operation of Orifice Meters[a]

By

K. I. SNYDER[b]

WHEN a stream of liquid or gas, flowing in a pipeline, encounters an obstruction, a drop in pressure results, and the condition becomes practically that of a liquid or gas escaping through an orifice from a chamber under a certain pressure to another chamber under a smaller pressure.

The greater the rate of flow of the liquid or gas in the pipeline, the greater the resulting pressure drop. If the size and condition of the obstruction remain constant in a given line, a given rate of flow of a liquid or gas will always result in the same pressure drop in passing the obstruction, and for any pressure drop there will be a definite corresponding rate of flow for the liquid or gas. The measuring device known as the orifice meter has been developed to make use of these facts.

An orifice meter consists of a standardized obstruction placed in a pipeline, in combination with an instrument for measuring the corresponding pressure drop. As the easiest form of obstruction to standardize and duplicate is a circular hole in a thin plate, the circular orifice plate is commonly used as the standardized obstruction.

The simplest form of device for measuring the pressure drop caused by the orifice plate is a closed glass "U" tube partly filled with liquid. One leg of the "U" is connected with a pressure tap above the orifice plate and the other leg with a pressure tap below the orifice plate. If the material flowing in the line is a gas, any liquid can be used in the "U" tube; but if the flowing material is a liquid, the liquid in the "U" tube must be heavier than the material in the pipeline and must be of such a nature that it will not mix with the material whose flow is being measured. Since mercury meets these conditions for any fluids usually measured, it is commonly used as the liquid in the "U" tube, and the mercury-filled "U" tube is commonly known as a manometer.

With this combination of orifice plate and a manometer installed on a pipeline, the rate of flow of any liquid or gas in the pipeline can be measured by establishing the relation between the readings of the manometer and the rates of flow, and applying this relation to periodical readings of the manometer.

The usual form of mercury type orifice meter recorders is merely a large mercury manometer with a float in one leg of the "U" tube driving a pen arm, which moves across a clock-driven chart and records variations in the pressure drop at the orifice plate. Having a known relation between the chart reading and the rates of flow, the rate of flow can be determined for any moment during the period covered by the chart record and, by adding together the rates for short periods, the average rate of flow, or the total flow for the whole period, can be determined at any time after the chart is removed from the meter.

The drop in pressure at the orifice plate varies with the weight or density of the material flowing in the pipeline. Thus, if a material twice as heavy as water were pumped through an orifice plate in a given line, the pressure drop indicated by the meter would be much greater than it would for water pumped at the same rate.

Since a liquid is practically non-compressible, variations in pressure at the orifice plate have practically no effect on the density of the liquid and on the orifice pressure drop when a liquid is being measured. Gas, however, is very compressible so that its density varies materially with the pressure at the orifice plate. Consequently, when measuring a gas with an orifice meter, it is necessary to measure both the pressure drop and the flowing pressure, and a second pen known as the static pressure pen is required in connection with an orifice meter for the measurement of gas. This may be installed to record on the same chart as the differential pressure pen, or on a separate chart.

Measurement by means of an orifice is not a new method of measurement. The early Egyptians probably measured time by the passing of water through an orifice. Water has been measured in this country for a great many years by means of an orifice.

The application of the orifice to the measurement of gas has been of more recent development and of necessity a great many modifications and improvements have been made. The orifice meter might be thought of as consisting of two essential assemblies. The first the orifice assembly and the second the recording mechanism. The first part of the orifice assembly may be very simple in some cases and in others it may be quite complicated. This depends on the type of fitting and the conditions under which it will be expected to operate. The more simple type would consist of two flanges made secure to the joining ends of two sections of pipe. These flanges will be very accurately machined so that a flat plate, in which will be drilled the orifice, may be fitted securely between them. This plate must fit gas-tight and the orifice centered in the pipe if we expect to get accurate records of the pressure and differential. For high pressure, this assembly must be more complicated to permit the required flexibility.

As we stated before, the orifice acts as an impedence to the flow of gas causing the velocity to increase while passing through the orifice and the pressure above the orifice to increase very slightly, and the pressure below the orifice to decrease. This difference in pressure is known as the differential and is measured by means of a U-tube filled with mercury and calibrated in inches of water. This U-tube of mercury terminates on one side in the float chamber of the meter proper and the other side of the tube terminates in a chamber of considerably less diameter than the float chamber. This U-tube and chambers function much as a U-gauge with a float on the low- or high-pressure side which is con-

[a] Presented to Southwestern Gas Measurement Short Course, held at Norman, Oklahoma, April 21, 22 and 23, 1936.

[b] Arkansas-Louisiana Gas Company, Shreveport, Louisiana.

nected to the recording mechanism. By connecting the float chamber side to the down stream side of the line, mercury will be caused to flow from the high-pressure chamber into the float chamber, thereby causing a difference in the level of the mercury in the two chambers. This difference in levels is known as the differential pressure and is measured as a difference in inches of mercury but recorded on the chart as difference in inches of water.

The location of the taps for connecting these columns of mercury is quite important as careless or indiscriminate locating will cause just as many different results in the record as we would have different locations. At present there are two types of tap connections used in practice. One is known as the pipe taps or the 2.5 and 8 pipe diameter connection, and in practice is as follows: the up-stream tap is made 2.5 pipe diameters upstream from the orifice. At that point the gas is supposed to be flowing without any interference or turbulence caused by the gas crowding through the orifice. The down-stream tap is made 8 pipe diameters below the orifice and at this position the gas is supposed to be in a straight-flowing condition without any disturbance caused by having passed the orifice. The other type connection is known as the Flange taps. In this case the taps are made at the Flange, one on either side of the orifice. With these connections, we do not get the true pressures of the line but we do have a greater differential shown. The gas on the up-stream side of the orifice tends to pile up at the flange and slightly increase in pressure. This is probably due to the inertia of the gas as it is moving through the pipe. On the down-stream side the pressure will be slightly less than the actual pressure due to the venturi tube effect after the gas has passed the orifice. These connections are exactly one inch from the face of the orifice plate.

Let us again turn our attention to the measuring and recording device or what might be termed the meter proper. We will begin by starting at the up-stream connection and follow to the up-stream side of the mercury column, then by following the column or tube of mercury through the "U" we arrive at a chamber partly filled with mercury known as the float chamber. In this chamber is a cast-iron float resting on the mercury and connected to a bearing shaft by means of an adjustable lever known as the float lever. Any change in pressure would cause mercury to flow in or out of the float chamber, causing the float to move up or down and this, in turn, would cause the bearing shaft on which the pen arm is located to rotate. Attached to the outside of the meter is a clock mechanism that rotates a paper disc known as the chart, usually once in 24 hours. The pen arm is so adjusted and the meter calibrated that the difference in pressure between the up-stream side of the orifice and the down-stream side is recorded in inches of water.

Another record is also made from the same taps, but this time using only one of the taps. (If full flow connections, the up-stream tap will be used; and if flange connections, the down-stream tap will be used.) This record is known as the static pressure and is measured by means of a hollow spiral tube mechanism known as a Bourdon tube, connected to another pen arm that records on the same chart. The strength of this spiral tube is so regulated that this pressure is recorded on the chart in lb. per sq. inch. The purpose of these records is for the determination of the velocity of flow that passes the orifice in a given time. Without this record it would be impossible even to estimate within a reasonable amount the quantity of gas that would be passing an orifice.

Orifice meters should be installed according to the American Gas Association specifications. These specifications give the minimum distance that the straightening vanes, regulators, and other fittings should be from the orifice; also the size pressure taps, their location, etc.

All orifice meters should be checked at least once a month and meters measuring large volumes should be checked twice a month. Checking twice per month on large-volume meters will save much trouble if the meter should be found fast or slow. The differential should be checked with a manometer reading in inches of water, the static pressure could be checked either by dead-weight tester or a good test gauge that previously has been checked on the dead-weight tester. The question is asked, "How often shall we clean orifice meters?" This is a hard question to answer as variable conditions and different cases cause meters to act in a different manner. The cleaning of a meter must necessarily be left to the judgment of each man for it is better to clean them too often than too seldom. In my district where we have clean dry gas, I clean the chambers about once a year and grease the bearings about twice a year.

Always check for leaks in the gauge piping before starting a test. In "zeroing" some meters it will be found that there may be a slight difference between the zero position of the differential pen arm when the meter is under pressure and not under pressure. If the zero position of the differential pen checks and the high readings of the differential pen on the chart do not check with the test gauge, make adjustment by increasing the length of the float lever arm when the reading is fast, and decreasing it when slow. When the gas shows pulsation which affects the pen arm marking on the chart, you can usually decrease the size opening between mercury chambers by a bushing or tapered screw, thus helping to make a nice record, but in no way eliminating the measurement error caused by fluctuations. When the static pen arm vibrates, the only remedy is to move the meter farther from the source of the pulsation.

The differential pen arms should be set "to arc" with the chart and the static pen arm set "to arc" with the differential pen arm, when an integrator is used to figure the charts. The space lag between the pens should be the same on the meter as on the integrator. Our company sets the pens for a space lag equivalent to 15 minutes at the zero position. When charts are figured by hand both the differential and static pens must "arc" with the chart.

We use a 50-in. manometer to check our differential pen and a test gauge to check our static. When meters are operating under 15 lb. it is good practice to use a mercury manometer as the error caused by static tubes is more pronounced when the meter is operating under low pressure.

The person who changes the charts on orifice meters plays a very important part and should be instructed thoroughly to obtain good measurement.

When the range of maximum to minimum flow exceeds the capacity of a single meter, a combined installation of 100-in. with a 20-in. meter increases the flexibility 2¼ times. This type of installation is especially suitable for measurement at town border stations.

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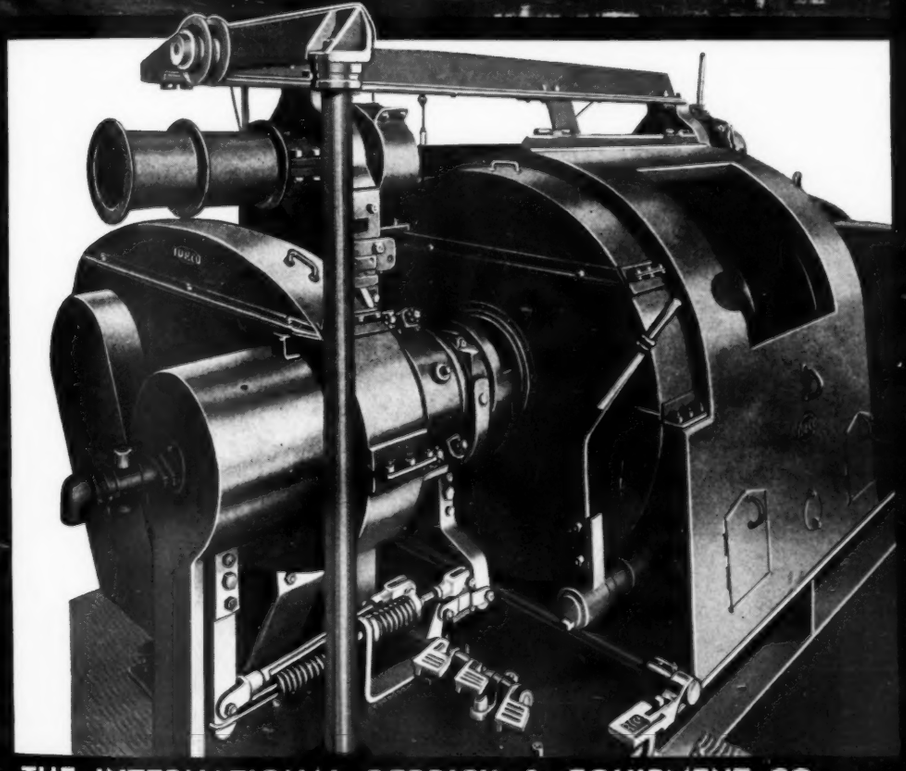

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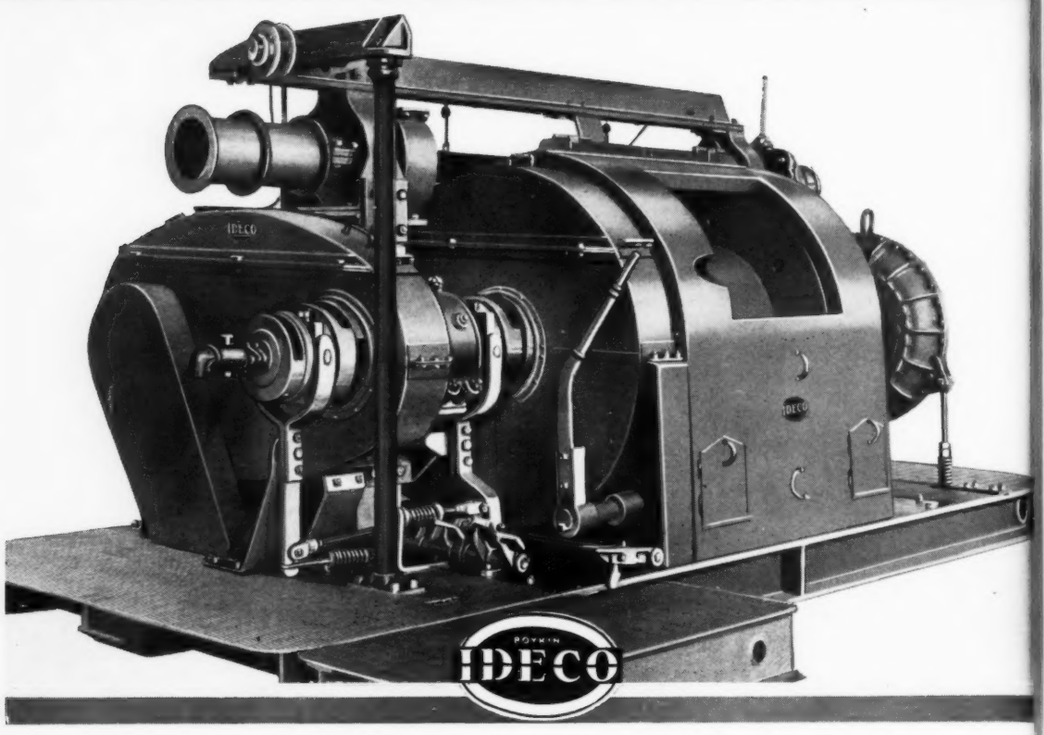

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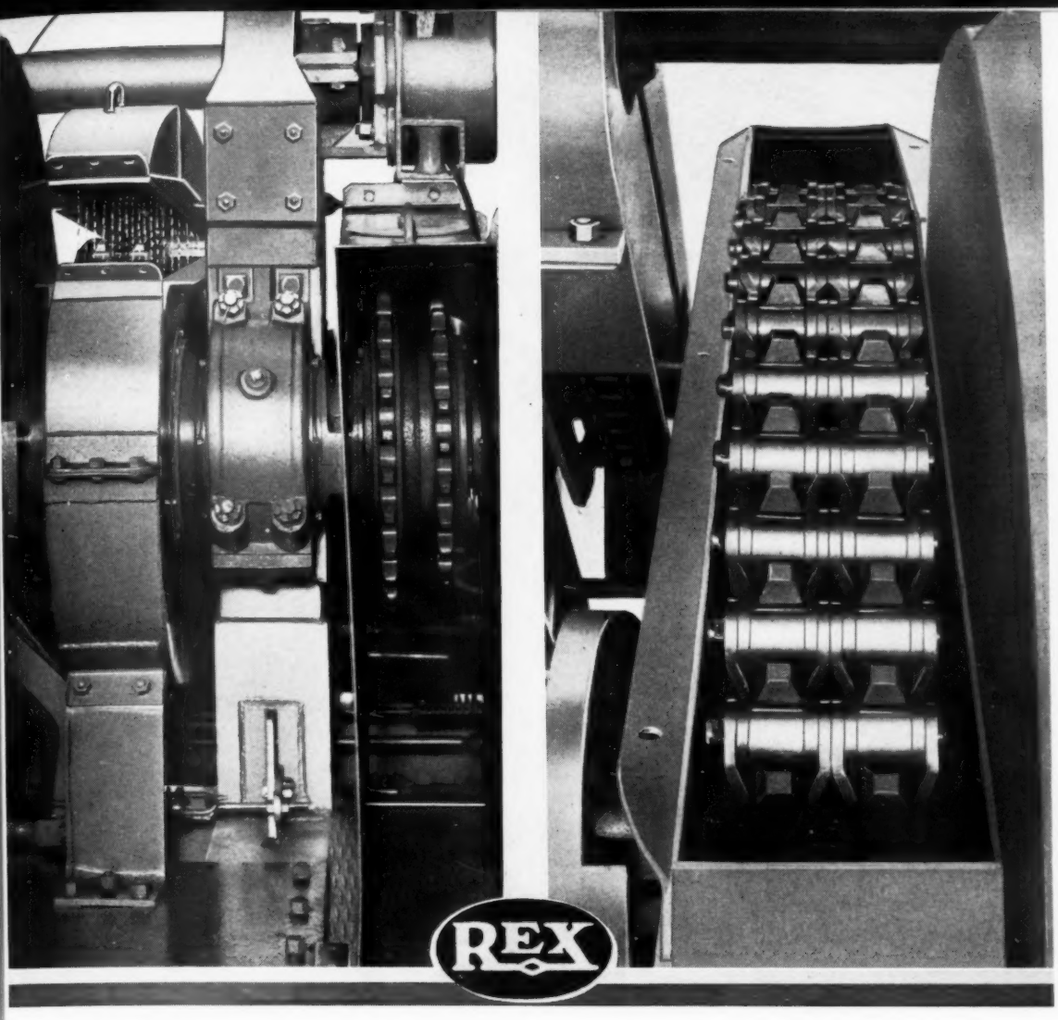

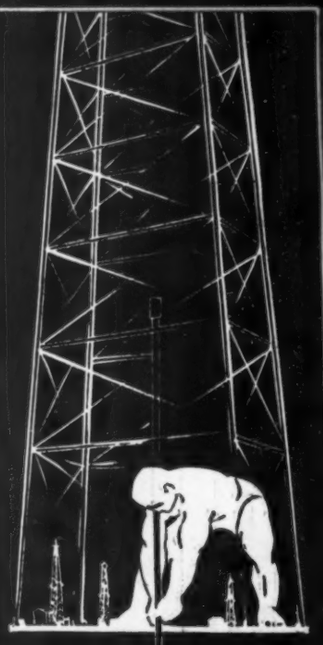

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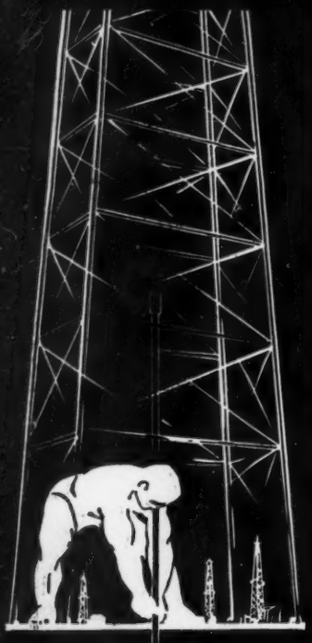

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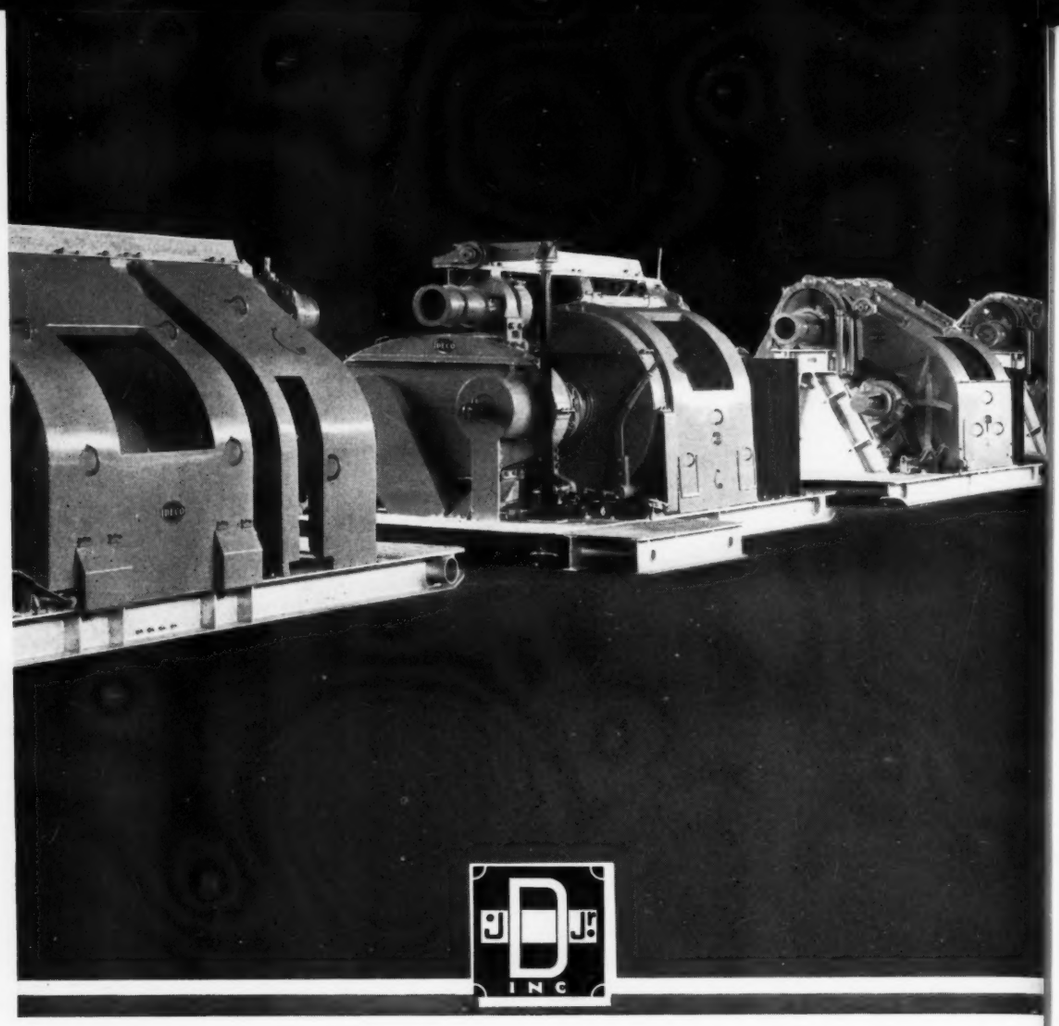

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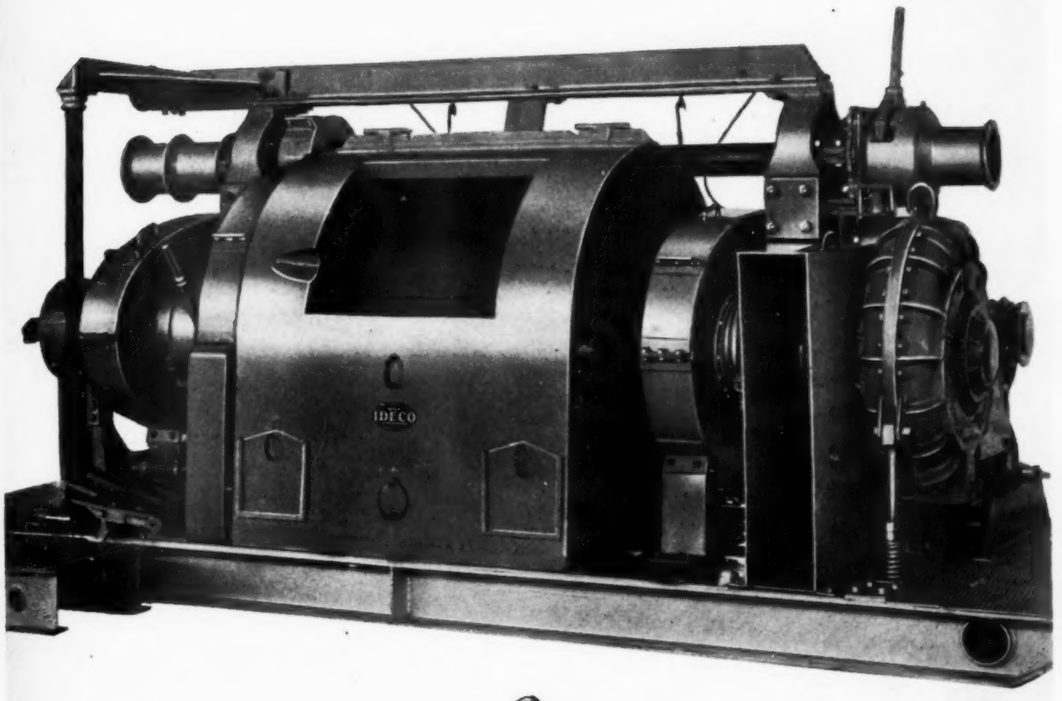

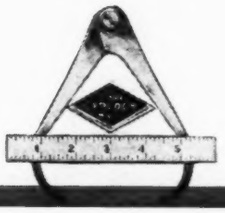

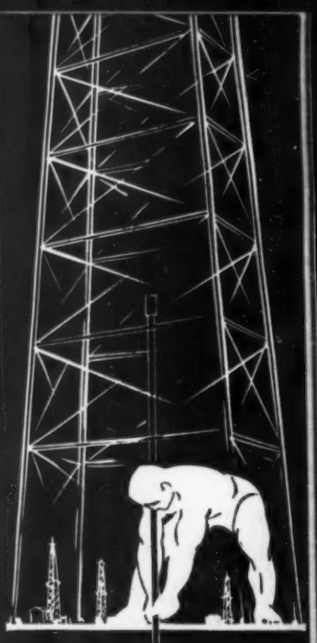

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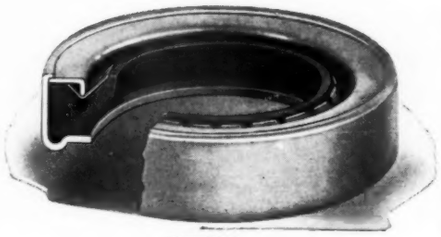

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The chains in this "Big Giant" Draw Works operate in fully enclosed guards and are lubricated continuously by circulating oil. To make these guards oil-tight is a tough job for which superior oil seals are required. That's why GARLOCK KLOZURES were selected by the builders.

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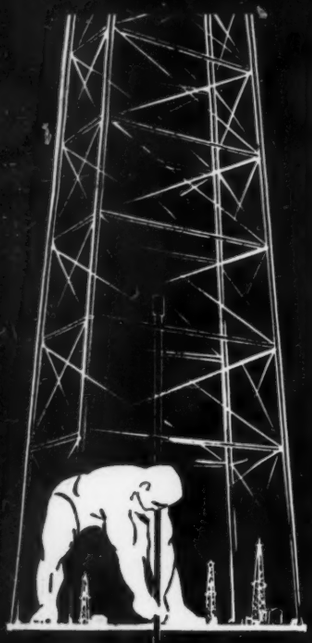

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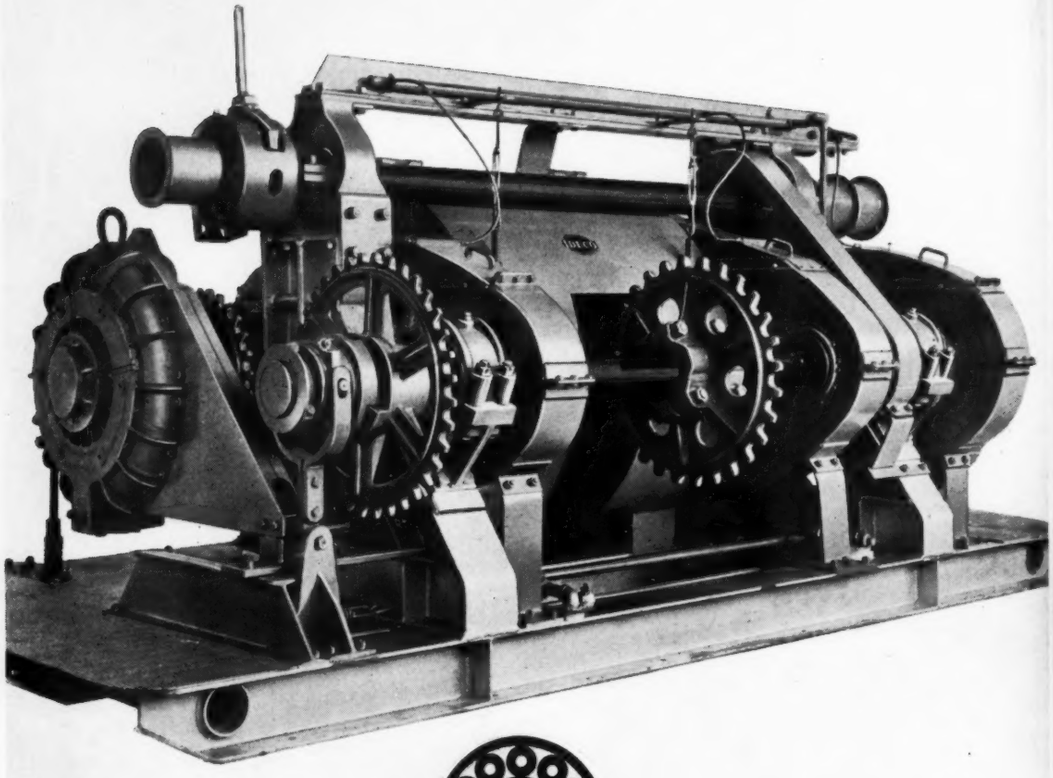

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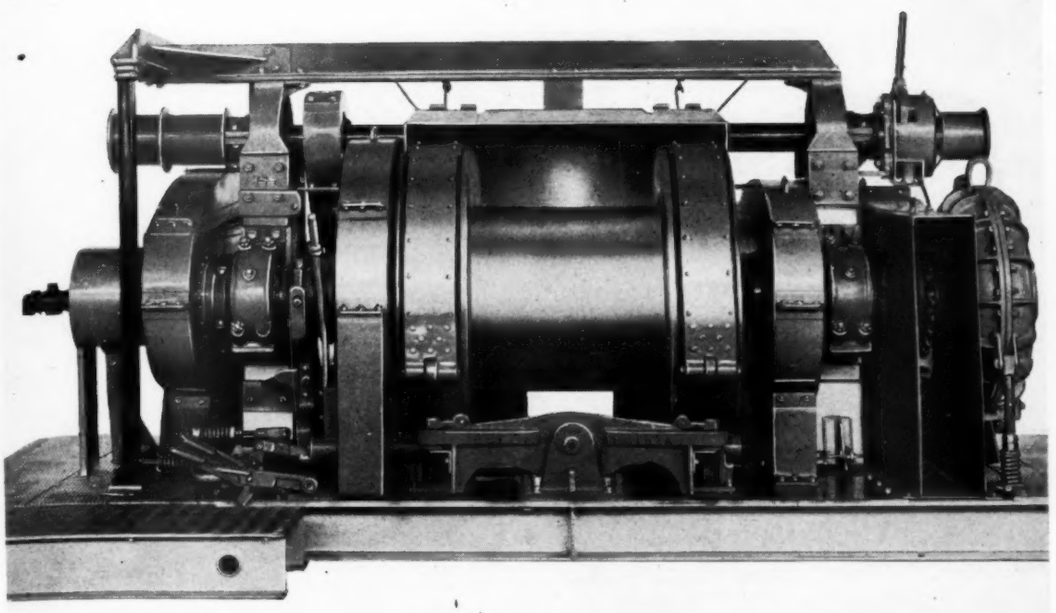

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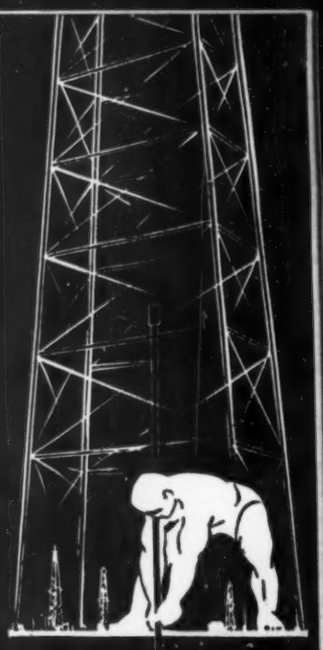

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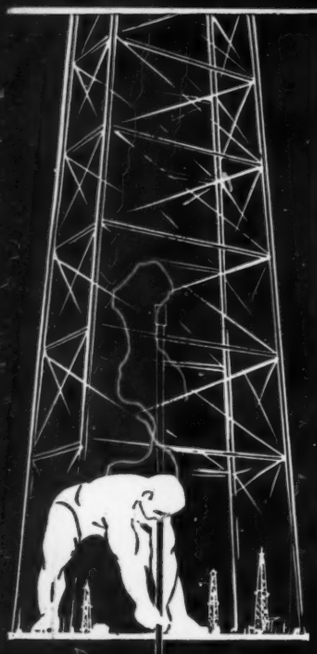

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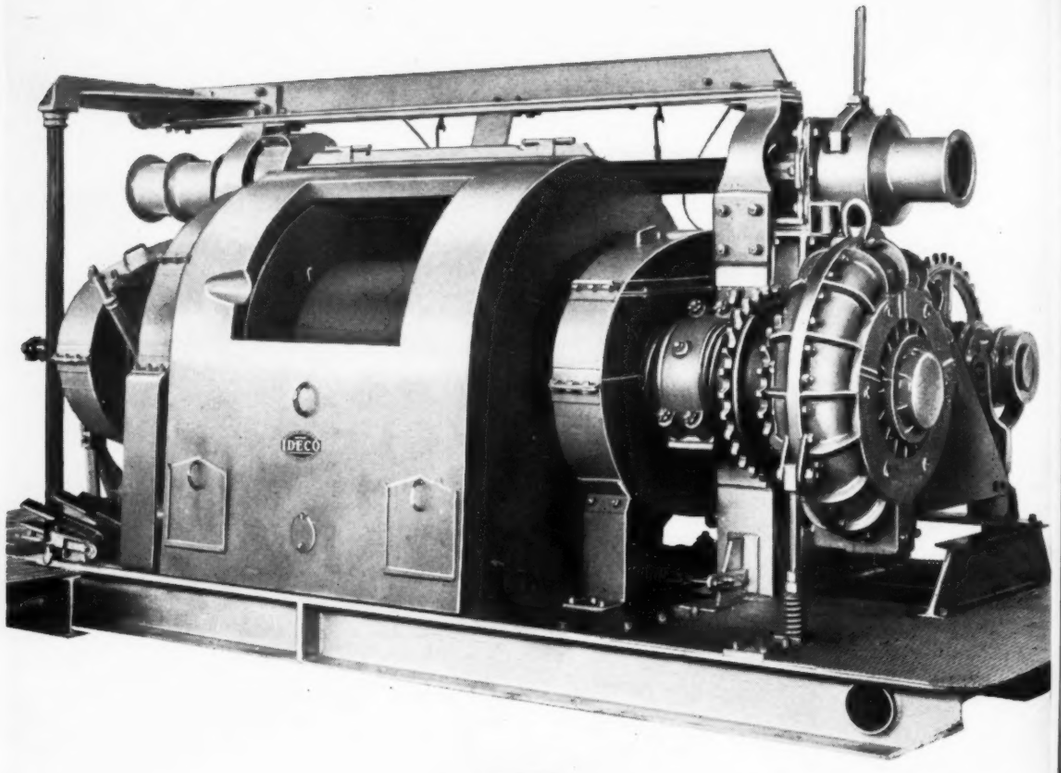

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Cathodic Protection of Pipe Lines

A Discussion of Variations in the Total Circuit Resistance of Electric Power Units for the Cathodic Method of Mitigating Corrosion of Pipe Lines and Other Sub-surface Structures

By D. B. GOOD

Electrolysis Engineer, The Texas-Empire Pipe Line Company

THE usual set-up for the cathodic protection of oil pipe lines, gas lines, or other sub-structures, is generally well known as consisting of a source of d-c. power with the negative connection to the sub-structure being protected and the positive connection to a ground bed or anode from which the current is discharged, the return circuit being through the earth and the underground structure.

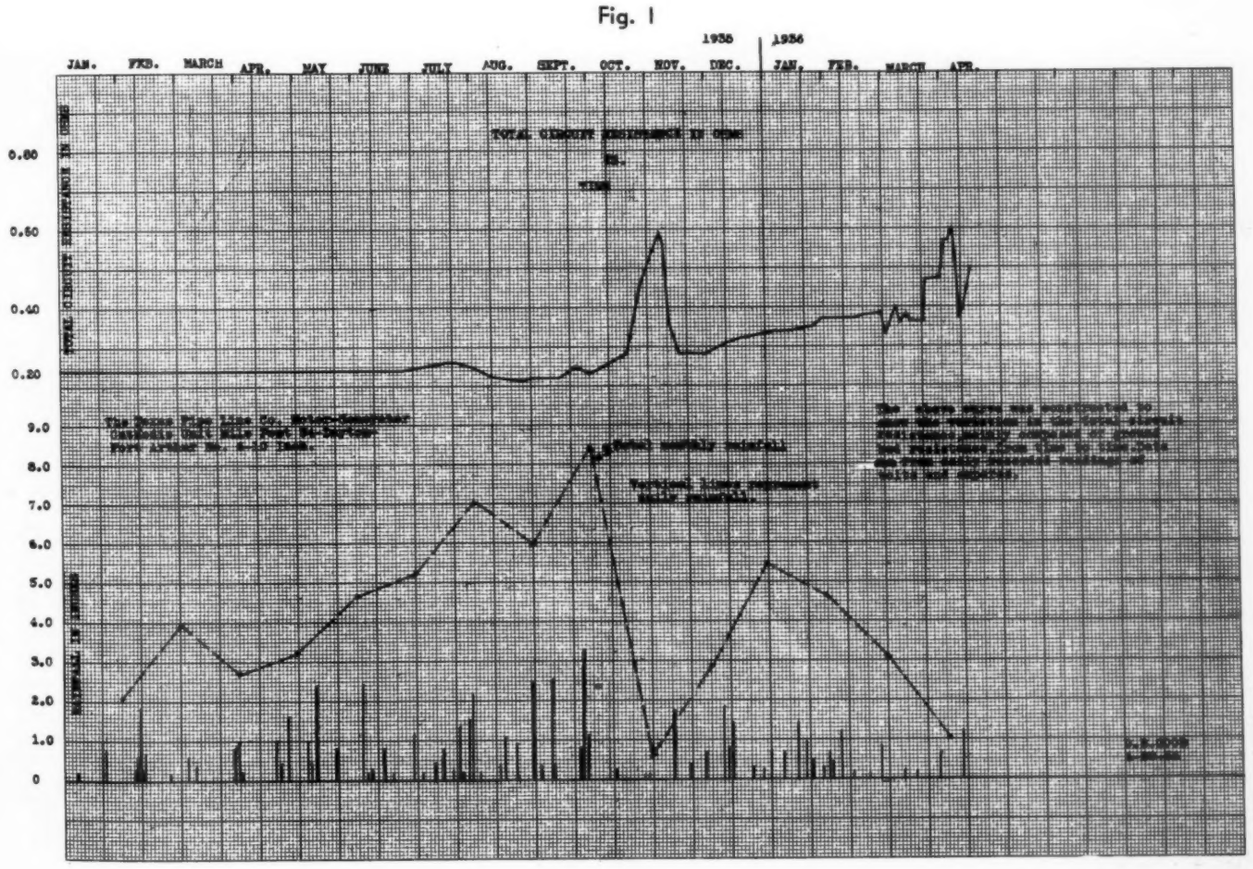
The total circuit resistance for this arrangement is the result of several factors, such as contact resistance between the anode and ground, pipe resistance, d-c. power circuit resistances, etc., but the major one is the anode or ground-bed resistance, which varies in different parts of the country according to soils, general earth conditions, and seasons, and in the same localities or spots according to the water content, up to a certain point, of the soil in immediate contact with the anode; also, contact resistance between anode and soil into which the drainage current is discharging is dependent to a certain degree upon the chemical composition of the soil, either naturally so, temporarily so, or made so artificially. However, other things being equal, and remaining nearly constant, the water content, to distinguish merely between dry and wet soil, is an important factor in the consistency or variation in the total resistance of a set-up such as herein discussed.

The resistance of a ground bed may be originally low or high, and is affected by the kind of ground bed used for making contact, the method of installation, and the classification of the terrain in which it is placed. In general, it might be expected that the variation in ground bed resistance would be less for clay, loam, or wet soils and greater in sand or rock.

The above discussion applies to ordinary grounds for the grounding of electrical systems, as well as to grounds for cathodic units. In the latter, however, the variations might be expected to be more acute or pronounced inasmuch as appreciable current densities are often maintained at the anodes.

Variation in the resistance of a ground bed means, of course, that the amount and degree of protection supplied to a pipe line can be affected materially if the voltage of the cathodic

Fig. 1



unit is constant or is left unchanged; and if the drainage current is affected adversely, being lowered appreciably and for sufficiently long periods, it is conceivable that the pipe or other substructure being protected supposedly nearly 100 percent actually might not be so completely protected, especially if the range of normal operation is within fairly close limits of a predetermined figure that will give complete protection.

Some argument might be presented that a smaller drainage current during a dry season would have a field of effectiveness somewhat equivalent to that produced by higher drainage currents during wet seasons, but if the soil were generally wet and corrosive in the pipe ditch, but not at the ground bed itself due to drying out from heavy current discharges, this would not be true.

As a means of showing the variation of total circuit resistance with time several curves have been prepared from records of daily readings of volts and amperes for several operating cathodic units.

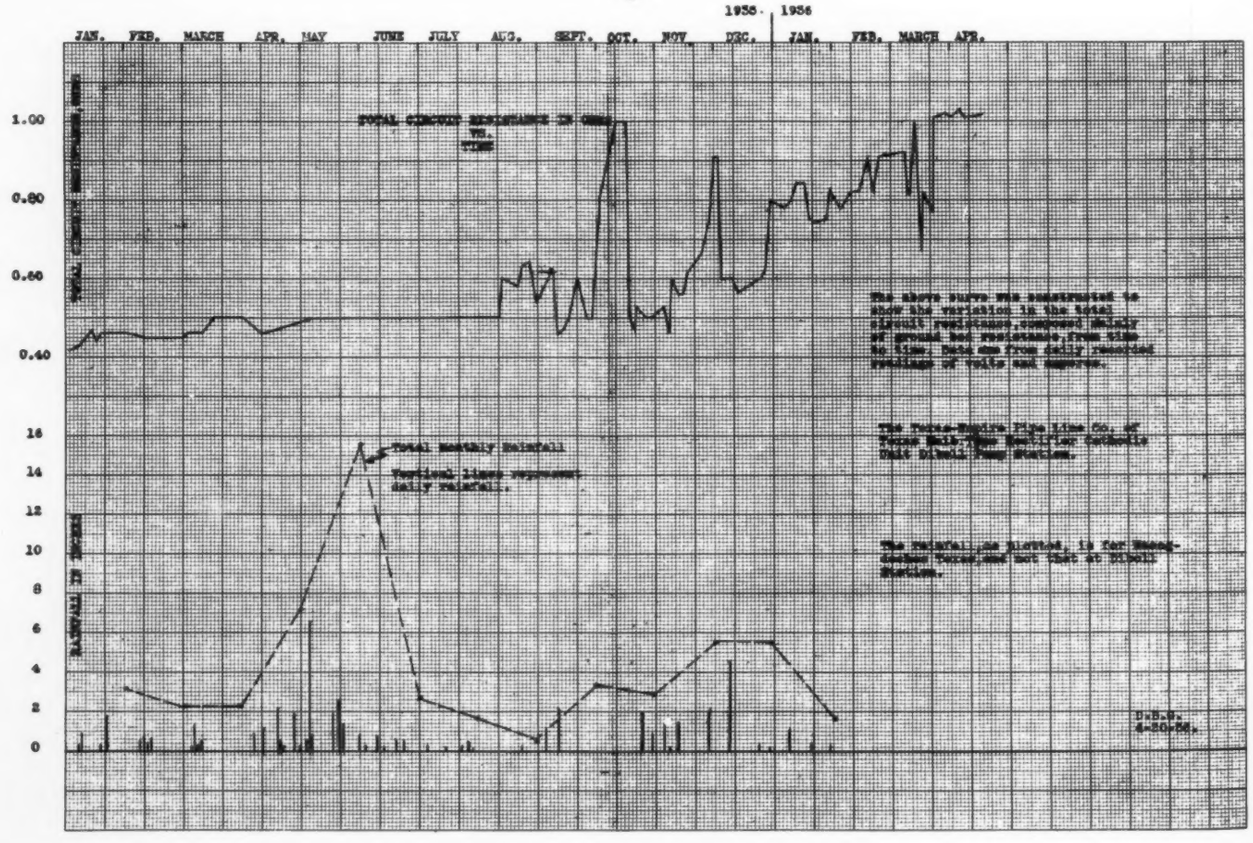
First, consider the cathodic unit on the No. 6—10 in. Dayton-Port Arthur line of The Texas Pipe Line Company near mile post 54 (Fig. 1.). Reference to the plotted curve shows, for the first nine months of 1935, an almost constant circuit resistance or current drainage. Towards the latter part of September a slight rise is noted, and by the middle of October the curve begins a rapid upward trend, remaining at a fairly high value, comparatively, for some time, until rains occurred, at which time it dropped; but toward the latter part of December there again appears an upward trend, which reached high values during the latter part of March and April.

This location is in a marshy area on the outskirts of Port Arthur, Texas. The ground bed is on slightly higher terrain than that in which the pipe lies, but the soil is a gumbo-clay, wet a great part of the time. As considerable current, between 40 and 80 amp., is being discharged to the ground bed it is likely that the current density is somewhat too high for the ground bed, and the condition noted on the curve, where the peaks occur, probably will occur oftener as in time the anode area becomes smaller. The curves of daily and total monthly rainfall in this instance follow remarkably close the resistance curve.

Reference to the second set of curves, (Fig. 2.), total circuit resistance vs. time, for the cathodic unit of The Texas-Empire Pipe Line Company of Texas at Diboll Station, shows occasional increasing resistance, or decreased drainage current, and is much more aggravated than the case just discussed. This may be explained by the fact that the ground bed in this instance is situated in a sandy type of soil of higher natural resistance than the one at Port Arthur and has no chance for constant or nearly constant wetness.

The reduction of some of the peaks as shown on the curve was effected by thoroughly watering the ground bed. In this instance, as in the previous one, there is noted a trend toward increasing ground-bed resistance since the latter part of December. These two locations are about 100 miles apart.

Fig. 2



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6 MORE EASILY PULVERIZED—While Fabric Bakelite is far stronger than concrete, it is easily pulverized by the drill and circulated out of the hole.

Is it any wonder that more LARKIN Float Shoes were used in the East Texas field during 1932-3-4-5 than all other makes combined?

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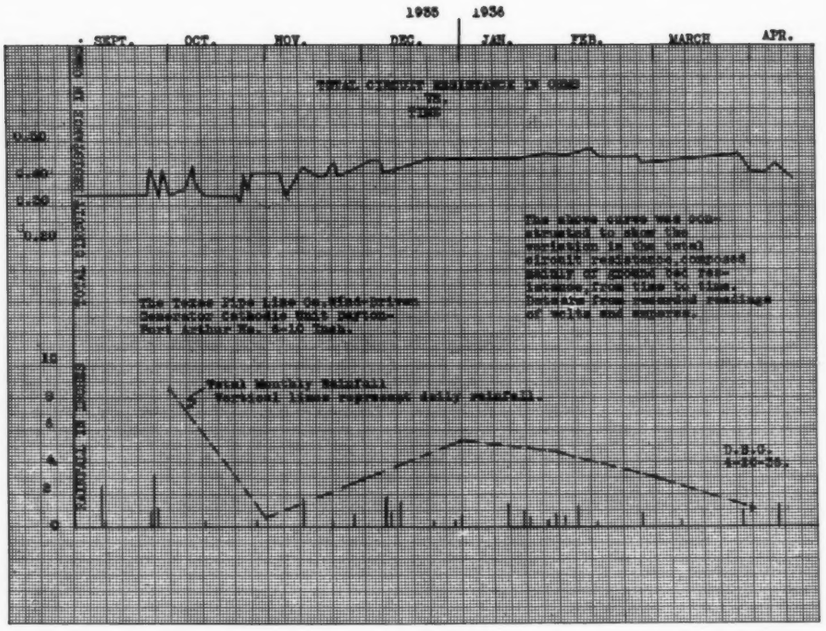
Fig. 3



The rainfall curves, daily and monthly totals, are for Nacogdoches, Texas, a point approximately 35 miles from the station location; notwithstanding, they have some correlation with the resistance curve.

The third set of curves (Fig. 3.) is for a wind-driven cathodic unit near Port Arthur, Texas. In this case the ground bed is within a few feet of a road ditch, whose water level is maintained by the back-water from Hilldebrant Bayou and thus is a constant source of wetness; also, the unit is in intermittent operation.

In conclusion, consideration should be given in a cathodic system of protection to the fact that the total circuit resistance, mainly ground-bed resistance, may vary more or less with time, depending upon locations, seasons, ground-bed designs, rainfall, and general earth conditions, and that these variations may or may not be sufficient to upset an established system of cathodic protection. In any event, suitable tests would reveal the overall average protection being obtained. For some ground-bed locations rainfall is a major determining factor in the variations of total circuit resistance.

Certainly further thought and study could be assigned to this phase of cathodic protection of pipe lines and other buried structures.

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612

A well drilled with cable tools. The sand has just been reached and the measuring line run preparatory to coring with a cable tool coring outfit on a wire line. Note the Manila cable still on the well

Cable Tool Coring in Flooding Operations

By E. A. GUENTER[1]

A Coring Contractor of Wide Experience in the Eastern Fields Here Sets Forth the Practical Aspects of Cable Tool Coring and Some of the Important Points to be Observed in Obtaining Good Cores

SINCE the introduction of water-flooding methods in the Bradford district of Pennsylvania, the cable tool core barrel has come to play an important part in oil production in that area. During the early flooding operations, many mistakes naturally were made and thousands of dollars spent in a manner that now would be considered unwarranted. When old holes were used, the casing was pulled and water was "dumped." This procedure occasionally proved satisfactory; but more frequently dirt and sand pumpings would fall down the hole when the pipe was pulled and, if no pocket had been drilled, much of the pay sand would be covered. The result was that only the top of the sand would be "flooded."

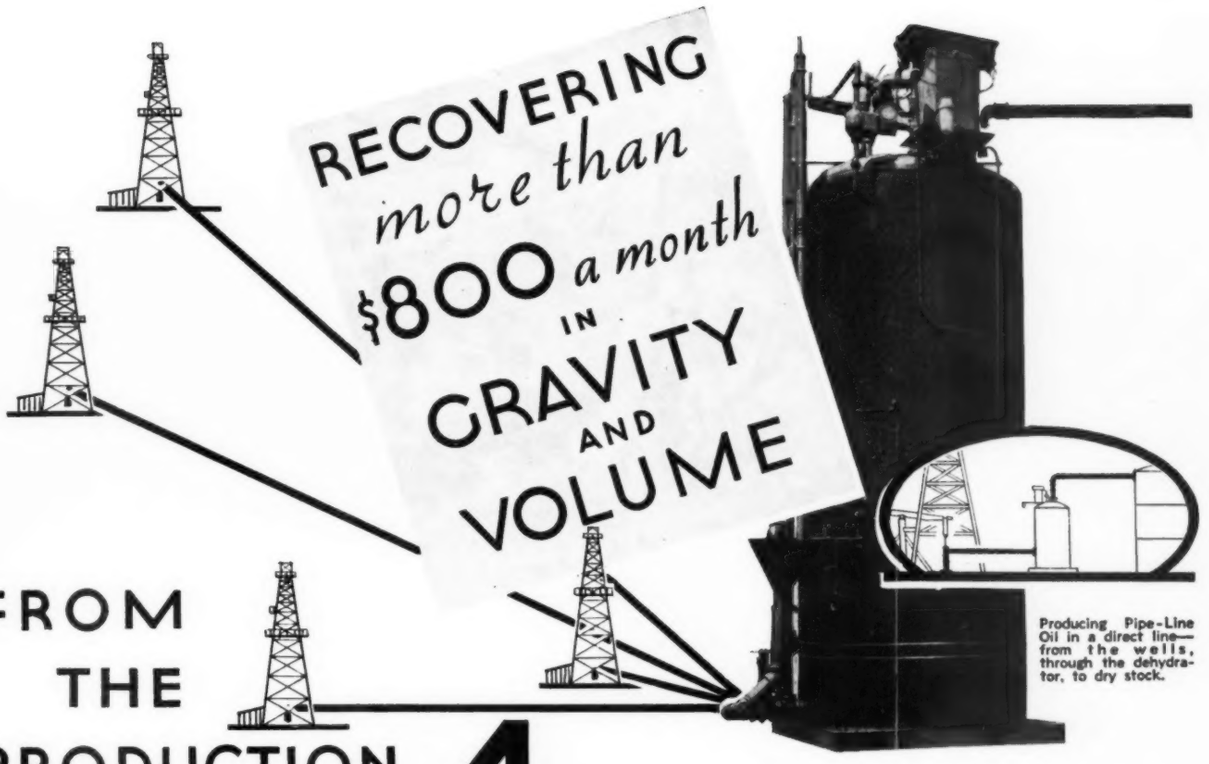
When new wells were used it was soon found that water traveled faster in some parts of the sand than in others. This could be corrected only by packers or by the use of different water pressures. Both methods were expensive and often unsatisfactory, for the correct pressures and positions for the packers were found only by trial and error. Oil men soon became acutely conscious that tests for saturation, porosity, and permeability were not only important, but that they were necessary. Diamond core drilling, however, was expensive. A good core that could be taken at a nominal cost was essential. It was to meet this demand and fill an increasingly felt want that cable tool coring equipment was introduced.

Cable tool core barrels have been used successfully not only in the Bradford field but in all other fields where standard cable tools are employed. Most of the large companies own coring equipment and use it frequently. Some of the smaller producers do not care to buy cable tool coring outfits, they prefer to have the work done by a coring contractor. A coring contractor, which happens to be the business of the writer, supervises the actual coring, makes a log of the well, and takes the core complete with saturation samples to a geologist for testing.

Usually the first question asked of the coring contractor by those seeking his services is, "How much will it cost?" It is impossible to give a definite answer concerning just what the core will cost. The formation, the number of feet to be cored, the power used, the depth of the well, and many smaller items, all enter in the question of cost. The accompanying table indicates clearly the importance of the formation in influencing cost. Here are two examples that show two extremes in the cost of coring a well.

(*Continued on page 67*)

[1]Coring Contractor, Coryville, Pennsylvania.



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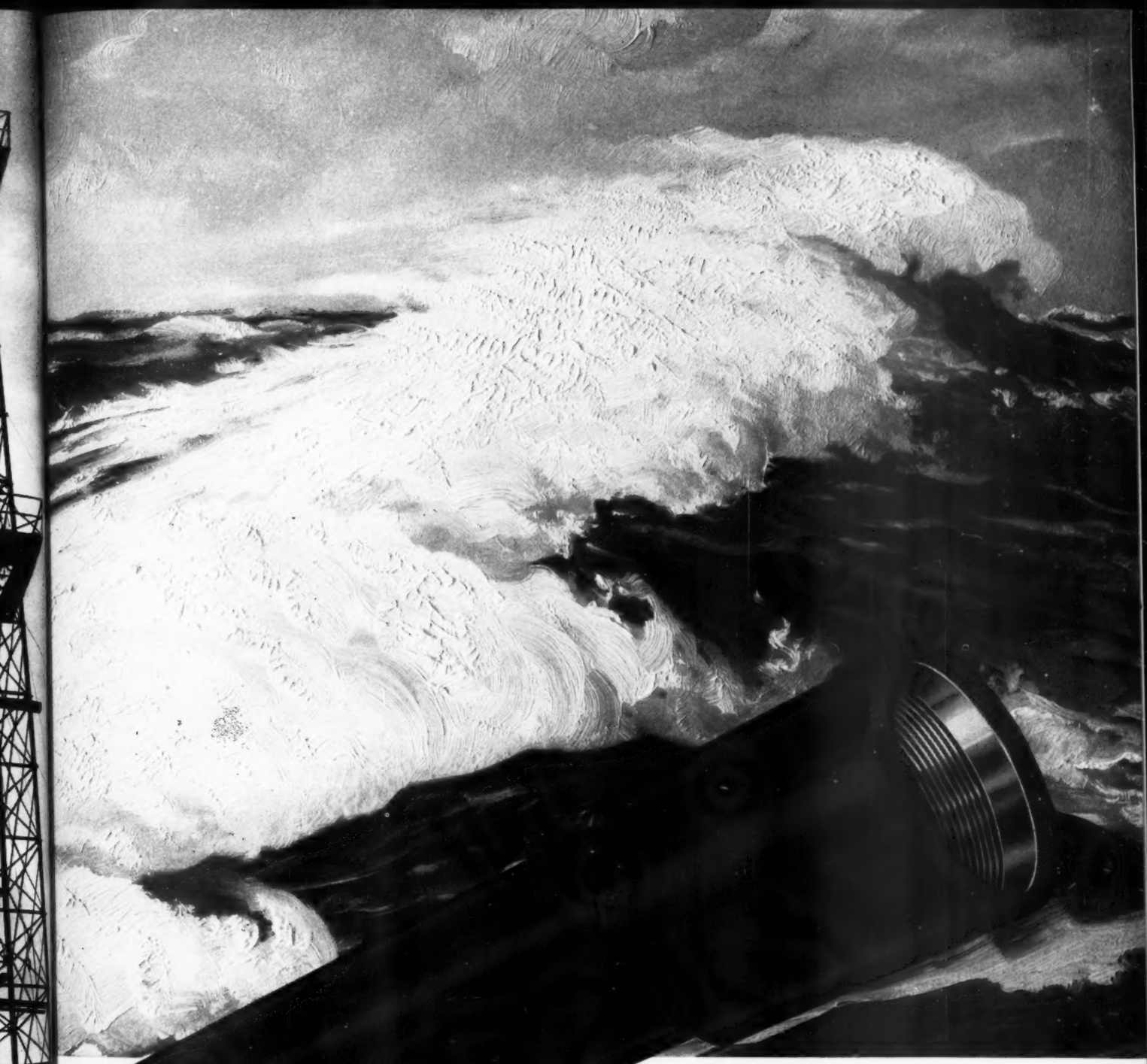

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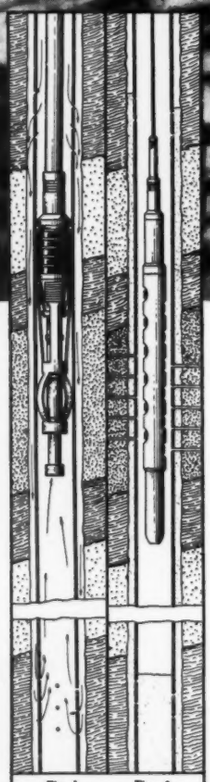

Fig. 1 Fig. 2

LEFT—Shows packer in position between two rings of perforations and formation being washed.

RIGHT—Shows casing after being cemented and Gun-Perforated.

SAYS "PERFORATING PETE":

"A lot of our customers are using Gun Perforator Service to help them get a good bond in their cement jobs. Here's how it's done:

"First, you have us make two rings of perforations, one ring at the bottom and the other at the top of the section behind which you want to cement—or, if you're on bottom with a casing shoe, only a single ring of perforations at the desired distance above the shoe will be necessary.

"Then set a packer like our Lane-Wells Circulation Type between your rings of perforations, and establish circulation down through the casing, out through the upper ring of perforations and along the outside of the casing, then inward through the lower ring of perforations and up through the tubing. (See Figure 1). You can do this either by swabs in the tubing or pump pressure applied to the top of the casing. This gives the formation a good wash, and at the same time the outward flow of liquid above the packer prevents sand or mud from heaving in on top and sanding up the packer.

"Now you're all ready to cement the entire section between the two rings of perforations, by any method you prefer, then—after testing for water shut-off—you call us in again to Gun-Perforate opposite your producing zone. (See Figure 2).

"Remember, too, that the accuracy of our Gun Perforator method makes it possible to space the shots closely or far apart, depending on the relative thickness of your oil sands, water sands and shale bodies."

Devices and method of operation licensed by Technicraft Engineering Corp. under Patents No.—1,582,184; 2,029,454; 2,029,478; 2,029,490; 2,029,491; 2,033,562; 2,043,340; 2,043,341; 2,043,400; 2,043,401.

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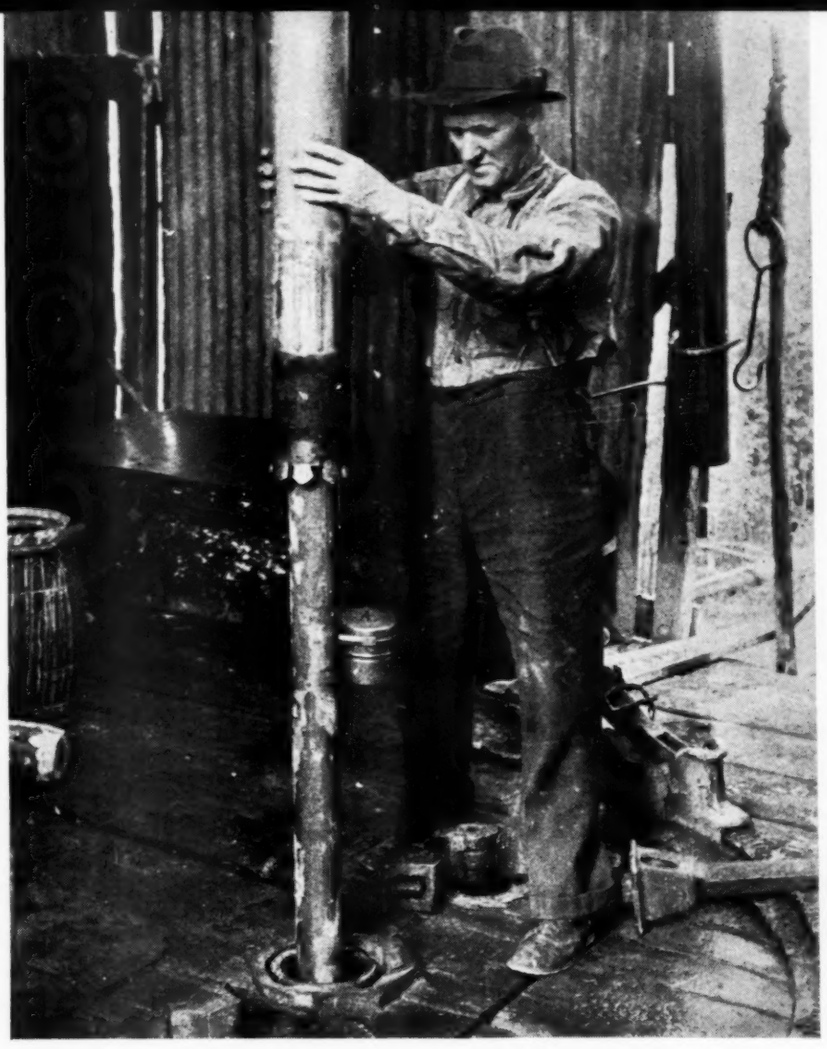


All ready to run the coring tool into the well

Case No. 5—Richburg Sand—17 feet—total cost of coring $177.71.

Case No. 6—Kinzua Sand—76 feet—total cost of coring $485.00.

Though the cost of coring is not definite it is not beyond the means of even the smallest producer to obtain cores of his wells.

The contractor is then asked, "How long will it take?" Here again no definite answer can be given, for the same reasons as those listed under cost. In the writer's experience the average time probably is about four days if no difficulties are encountered. Certainly there is no trouble in "rigging up," for once the tools are on location they can be strung up ready for work in 30 minutes.

Another question frequently asked the contractor is: "What method do you use? Can my driller do the work?" In this connection, the writer, who uses Baker coring tools, finds that experience is not necessary in their use. Frequently the writer has had drillers who never before saw a coring outfit; it should be stated, however, that some person familiar with the technique of coring should supervise the entire operation.

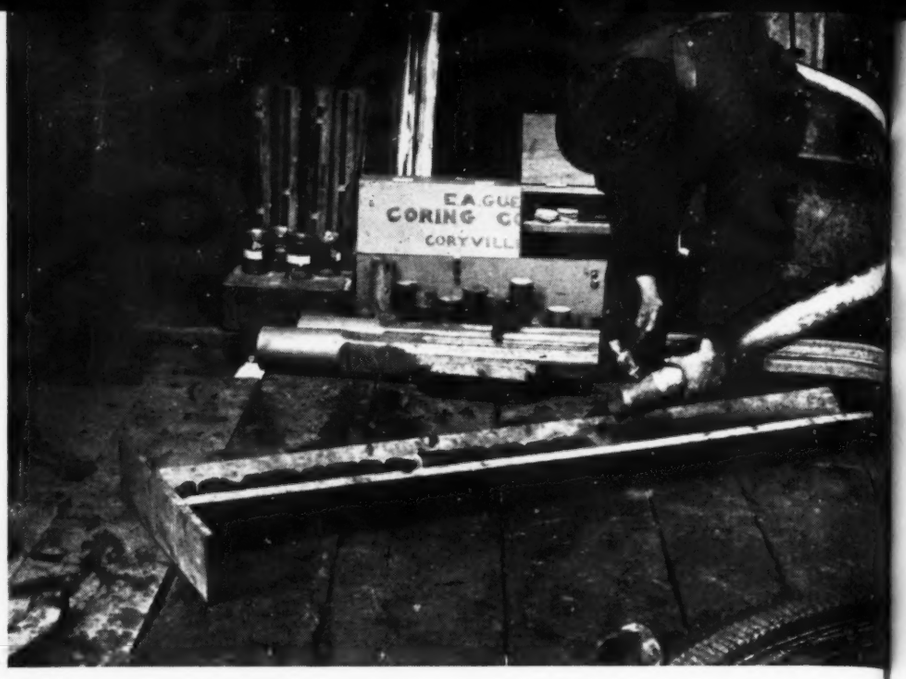
From 85 to 95 percent recovery usually is obtained and when the formations are not too hard an almost perfect recovery is believed possible. To get a high percentage recovery the following rules are observed. Assurance is made that the core barrel is of proper length, for when the tubes are rethreaded they are shortened and the barrel is then too long. The valves are checked to see that they are functioning properly. The wrist pin should be set at the second hole; or, when using a five-hole crank, at the third hole. Enough water is kept in the hole to cover the tools. A 30-in. to 32-in. stroke and a speed of about 30 strokes a minute are used.

It is natural for a driller to want to "make hole," but warning should be given about working too fast. It is most important that the core tube be on bottom all the time. When using a standard rig, a large stem can be employed; but if the rig is a smaller type, a shorter stem is required to leave room for the jars. The jars are placed on top but it is possible to use them on the bottom. When they are used on the bottom there is less danger of getting "hung up" but they must be heavy enough to withstand the strain. For best results a wire line direct with ordinary wire line socket is used; however, a short "cracker" is permissible. When a standard rig is used, a 30-ft. stem and 10-ft. sinker (with the jars placed in the middle) make an ideal arrangement. Coring can be done efficiently with any kind of power—steam, gas engine, or electricity.

Eight bits should complete a well of from 50 to 70 ft. in the average type of formation; more than one run, however, is never made with a bit. When the last fresh bit has been used, all the bits are laid on the floor with the teeth up. By means of calipers the largest bit is then selected for the next run; this procedure is repeated until the well is finished.

Plenty of repair parts should be always on hand so that the job will not

Checking the valve in the drill stem before running into the well



Removing the core from the core barrel into the trough. Note the containers for samples in the left background

be held up in case of trouble. If the tongs for the drill barrel start slipping, ridges are put on each end of the drill barrel with stellite. If the tongs for the core tube slip, new pins are inserted and assurance made that the dies are in good condition. When "breaking" a bit the crew must not place the tongs too close to the end of the barrel so that the barrel will not be strained. It is not necessary with the trimmer shoes. The tube with the trimmer shoes, when run properly, should remain constantly on the bottom of the hole; then there is no jar or strain and the shoes need not be set too tightly. If the shoulder on the upper end of the core retaining tube is worn it should be built up. To fail to do so will cause the tube to slip through the bit and result in a fishing job. Occasionally the core retainers are not spaced evenly, so they should be spread carefully to see that they are of equal length. The screw holding the pin in place must be kept tight. If the valve seat in the drill stem becomes worn, it is drilled and a new valve inserted. By following these rules a good core should be obtained.

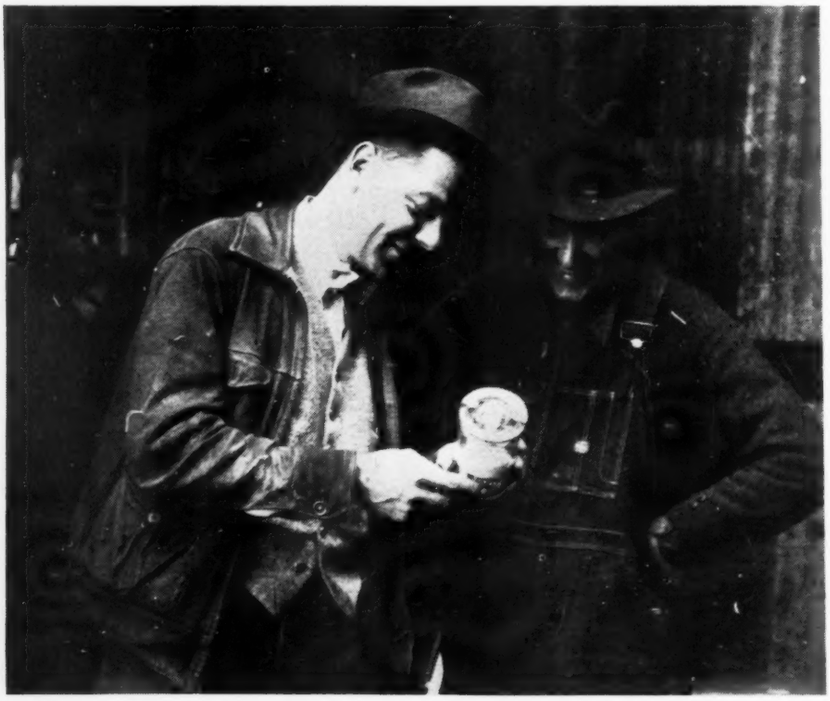
DATA ON TAKING CORES IN DIFFERENT TYPES OF FORMATION[1]

Sand	No. of well	No. bits used	No. shoes used	No. feet cored	Time required
Kane	1	4	2	55	2 days
Chipmonk	2	5	3	44	3 "
Trenton	3	4	5	34	5 "
Bradford	4	8	3	63	6 "
Richburg	5	4	1	17	1 "
Kinzua	6	14	5	76	12 "
Clarksville	7	6	3	65	5 "
Scio	8	4	2	36	3 "
Bradford	9	12	4	133	8 "

[1]These data were taken from the records of E. A. Guenter, Coring Contractor, Coryville, Pennsylvania.

Included in the formations cored by the writer are the Bradford, Haskell, Kane, Chipmonk, Clarksburg, Richburg, Scio, Kinzua, and Ohio Trenton Rock. It is an interesting fact that oil sands usually are much easier to core than mixed formations or hard shale. Perhaps the hardest sands to core are the Kinzua and Ohio Trenton Rock. In the latter formation the writer cored, he believes, the first well in Ohio with Baker coring tools. Having cored principally in the Bradford field and its vicinity he was surprised not a little to find that the jars were not necessary in the limestone since there was almost no wear on the bits. One bit could be used numerous times; the trimmer shoes, however, were changed every run, four shoes usually being sufficient.

Coring in an ideal sand having a porosity of 16 to 18 percent, a saturation indicating a recovery of 6000 bbl. per acre, and with the outfit functioning smoothly, core biscuits of from



Art Simmons, geologist of Bradford, and E. A. Guenter, the author, looking at part of core selected for saturation test

three to five inches in length are common. Under these conditions an almost perfect recovery can be expected.

A dry core, just enough for saturation tests, has been taken without using water; however, it is impossible to core very much without using the right amount of water.

Once the core is obtained its care involves a definite procedure. A Baker hydraulic core extractor is used. After the trimmer shoe has been removed a ⅜-in. rope is looped about the tube near the head end. The chain hoist is then used to elevate to the desired height and the bottom end of the tube placed in a specially prepared 5-in. by 6-in. by 7-ft. trough and tapped gently with a hammer. The core will be found to come out easily and it must be placed in the trough just as it comes out of the tube.

By accurate measurement the recovery is determined. Before the sand is washed samples are selected and removed for saturation tests, wrapped in tin or lead foil and placed in air-tight containers; glass jars that can be sealed are often used. In place of the sample removed for test a round wooden block is inserted in the tin and labeled correspondingly. The jars are also labeled by means of adhesive tape and identified by test number, depth, and run.

The remainder of the core may now be washed and placed in the tins. The writer uses and recommends a made-to-order type of tin. It is 48 in. long, partially covered on one end and has a removable cap on the other. The sides have holes so that the tin may be laced as tightly as desired. Geologists prefer the tins for they enable them quickly and conveniently to remove such "biscuits" as may be desired for porosity and permeability tests. Another advantage of such a tin is that it may be used repeatedly.

Round wooden blocks are placed in the tin after every run, a notation being made of the depth on the outside by means of adhesive tape in the same manner as that used for the saturation samples. Measurements are important; and while the figures given by a sand line after every run are usually reliable, the measuring line should be run after every fourth run to make doubly certain.

A good coring outfit is like a car. It will keep running perfectly as long as it is kept in shape; and since a reliable coring outfit is easy to keep in shape it may be used indefinitely.

This picture shows you

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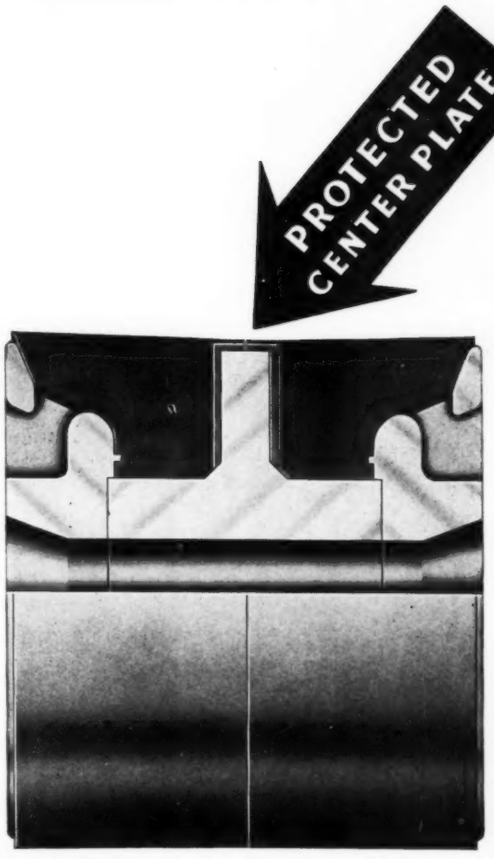

The design of the MacClatchie "Wearever" Pump Piston is the outcome of years of research and field tests. Experience has taught us that; no steel should come in contact with the liner — that the replaceable rubbers must be supported on the pressure stroke with a rigid steel member —and that on the suction stroke the rubbers must be supported at the rear with some stiffening means and be held against suction with a guard such as our perforated end plate. It takes all of these features to obtain the best piston and liner efficiency. Only in MacClatchie Pistons can you find this real economy.

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Installation of cathodic unit in which large casks (hogsheads) are used for battery cells

The method discussed in this article has the merit of producing current economically, is applicable to any location, the equipment can be constructed of any size, and no large cash outlay is involved.

Junk Iron as a Source of Current for Use in Cathodically Protecting Underground Metallic Structures

By S. U. McGARY, Engineer
United Gas Public Service Company

IT has been determined beyond question that if the electrical potential of a buried structure is changed and kept sufficiently negative to the adjacent soil, corrosion will cease completely. Since this became known many methods and devices have been perfected for the production of electricity to be used in the protection of pipe lines. These devices consist of rectifying devices for changing alternating current to direct current, wind-powered generators, and turbines that are driven by the movement of the product being transported in the pipe line. Metallic zinc and other metals that have sufficient electro-chemical difference with iron have been proposed and are used to some extent in protecting pipe lines from soil corrosion.

The method to be discussed in this article consists of another device that operates by the corrosion of scrap iron to produce electricity.

Description of the Process (Fig. 1). Into the bottom of a container of glass or wood is placed a copper plate. This copper plate is covered with a concentrated solution of copper sulphate. Above the copper sulphate solution is a 1 percent solution of calcium chloride to which ¼ percent of acetic acid is added. It has been found by experimentation that this solution will allow the iron to corrode without forming a protective scale. The solutions have a gravity difference only sufficient to maintain a complete separation. Into the top solution is placed the piece of iron that will undergo corrosion and thereby supply electricity for protecting any buried metallic structures. One terminal of the battery is attached to the copper plate and the other to the iron plate. Over the top of the container is placed a film of oil to prevent oxidation of the iron.

Operation of the Cell. When current is drawn from the cell the following reactions take place at the plates:

Iron

At this plate the iron goes into solution and as each ion passes from the metallic to the ionic state two electrons pass through the metallic conductor as given in the following equations:

Fe°	—	$2(-)$	⟶	Fe^{++}
Metallic Iron		Electrons		Iron Ion

At the copper plate the ions enter the solution and metallic copper is de-

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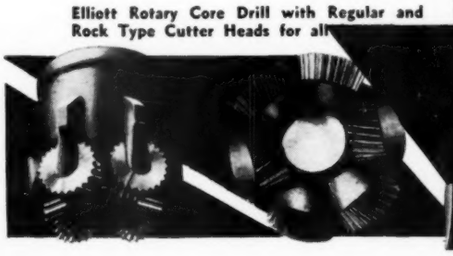


Elliott Cable Tool

ELLIOTT

CORE DRILLS

posited from the solution of copper sulphate according to the following reaction:

Cu^{++}	+	2 (—)	⟶	Cu°
Copper Ion		Electrons		Copper Metal

These reactions will continue until either the iron or the copper sulphate is exhausted. In order to salvage completely the copper in the copper sulphate the cell is so constructed that the iron being corroded is of sufficient quantity to precipitate completely the copper in the copper sulphate as metallic copper.

It is possible, if the container is sufficient in depth, to place in the battery a quantity of chemicals sufficient for one year's continuous operation.

Cost. The following is an estimate based on the present price of chemicals for the production of one amp. for one year. This estimate covers only the purchase of the chemicals.

Chemical	*Amt.*	*Market Price*	*Remarks*
Iron	20 lb.	0	In junk stock
Copper sulphate @ 4c per lb.	88 lb.	$3.52	
Calcium chloride and acetic acid		.10	
Total Cost —		$3.62	per amp. year

At the end of a year 22 lb. of metallic copper would be salvaged that could be sold for nine cents per lb., giving the operation a credit of $1.98. This would leave the cost of producing one amp. for one year $1.54.

If the 22 lb. of copper was reconverted by treatment with sulphuric acid to copper sulphate and used again the cost of recharging the cell for the second year of operation would be as follows.

Chemical	*Cost*
Sulphuric acid for converting metallic copper to copper sulphate	$0.60
Calcium chloride and acetic acid	0.10
Copper foil	0.01
Total cost of chemicals if copper is recovered for producing one ampere for second year operations	$0.71

The theoretical voltage of this cell is .77 volt, but the cells constructed as here described produce at a voltage of between .65 and .70. This, however, is approximately twice the voltage that it is possible to obtain using zinc metal attached directly to the pipe lines.

There has been installed on a pipe line a battery of this kind using large casks (hogsheads) for the battery cells. The plates in each end were about five sq. feet. The casks held enough chemicals for one year's continuous operation. Each cell is capable of delivering on short circuit 1.8 amp. with an open voltage of .7.

Under load at this particular location a cell delivered .9 amp. at .45 volt. The merits of this device are as follows:

(1) It produces current very economically.

(2) Is applicable to any location on pipe lines.

(3) Can be constructed in any size.

(4) Involves no large cash outlay.

The disadvantage is the fact that in order to produce a large amount of current it would necessitate the use of a ground bed of very low resistance. This, of course, can be accomplished by the use of a large amount of scrap around which has been placed a large quantity of salt.

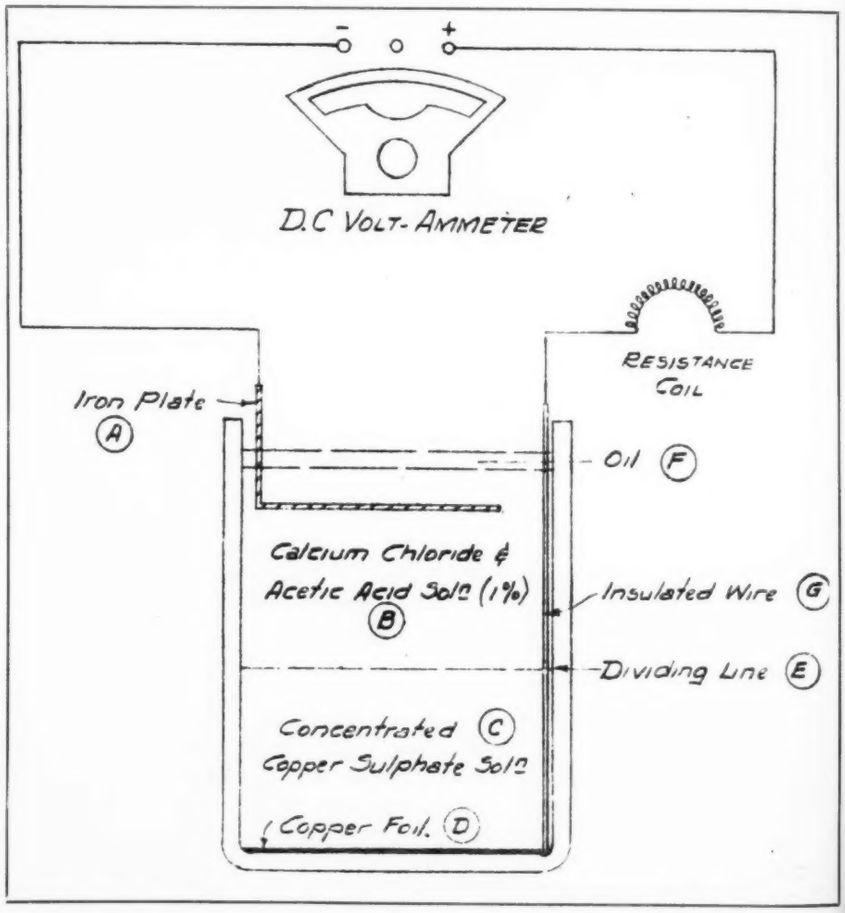
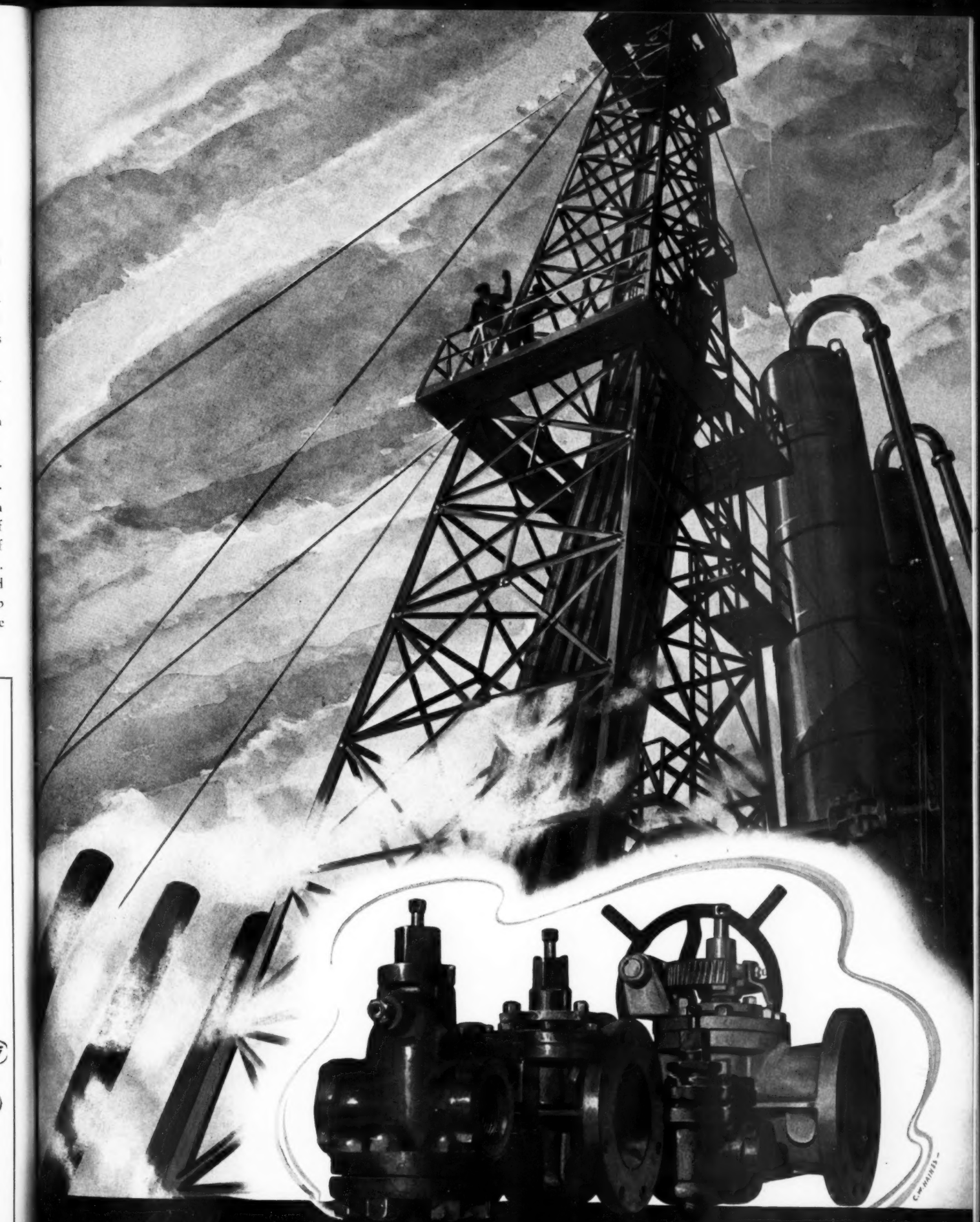


Fig. 1.

Diagram of cell used in laboratory to produce current. A. Iron plate. B. One percent solution of calcium chloride acidified with acetic acid. C. Concentrated copper sulphate solution. D. Copper foil plate. E. Dividing line between the two solutions. F. Film of oil excluding the air. G. Insulated wire attached to copper foil.



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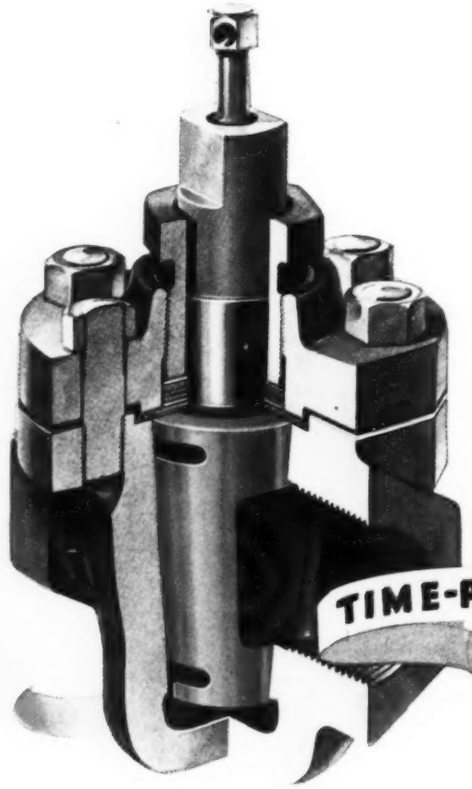

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By

EMORY N. KEMLER

In showing the results of beam and rotary counterbalancing with respect to reduction of peak power requirements, the author discusses the effect on peak rod load, on the shaking forces in foundations, and on stresses in pumping equipment.

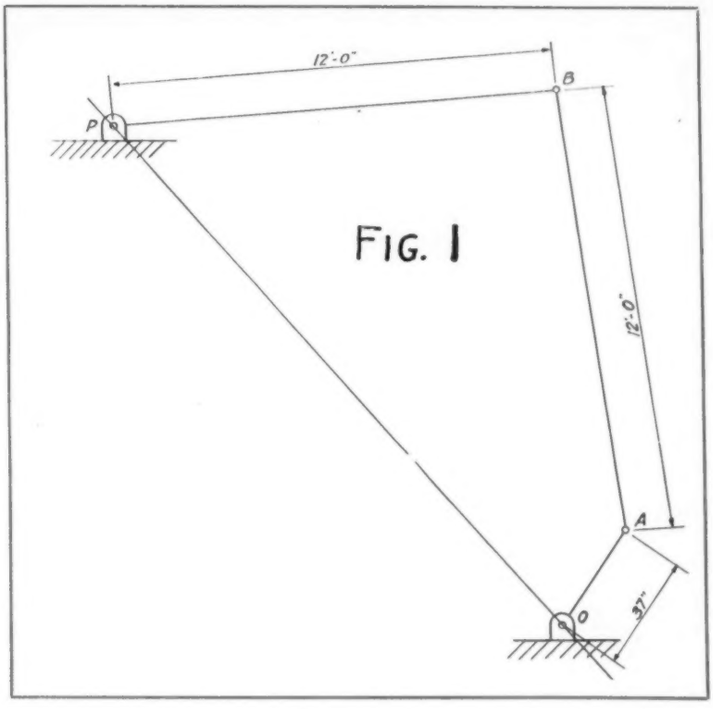

FIG. 1

Comparison of Beam and Rotary Counterbalances

IN a preceding article[1] it was shown that so far as the effect on reducing peak power was concerned, the beam and rotary counterbalances had equivalent effects. There are, however, other factors that should be considered. Among these are the effect of counterbalance on peak rod load, effect of counterbalance on the shaking forces in the foundations, and the effect of counterbalance on stresses in the pumping equipment. These factors will be discussed briefly and in the order mentioned.

Effect of Counterbalance on Rod Loads

The effect of counterbalance on rod loads will not depend on the kind of counterbalance, but if there is any difference, it will depend on the amount of counterbalance used. A well properly counterbalanced for power consumption may not necessarily be operating with the most desirable rod load. The following qualitative analysis shows that it is possible that the rod loads with small amounts of counterbalance might be less than with the full amount of counterbalance. With small amounts of counterbalance it can be seen from Figs. 1-c and 4-c (p. 35, May issue) that the engine load fluctuates widely, causing a corresponding wide variation in speed of the prime mover. As a result, when the engine starts on the upstroke it must supply a high instantaneous power, and since it is limited in the power it can supply, the speed is reduced on the upstroke. As the engine slows down the acceleration is reduced and a longer time will be taken for the upstroke. The lower dynamic rod load and the change in speed may affect the maximum rod load; however, this effect should be small unless there is quite a speed variation. With full counterbalance the peak power required will be reduced and the speed fluctuation will be decreased. While no counterbalance may result in lower rod loads for reasons just stated, there is no doubt that stresses in the rig will be higher and the equipment will not run so smoothly.

Effect of Counterbalance on Shaking Forces in Foundations

When the pumping rig is mounted on pile or insecure foundations the shaking forces may be a factor that should be considered. To illustrate the effect of beam and rotary counterbalances on shaking forces in the foundation the three following cases have been worked out. Fig. 1 shows the proportions assumed and the manner in which crank positions have been measured.

A. No Counterbalance (Fig. 2)

The method of procedure was to lay out the mechanism in 24 positions and, using a load of 1000 lb., to find the components of the forces set up in the various members of the mechanism. In this analysis it was assumed that the polished rod load was vertical. This assumption does not involve any appreciable error and greatly simplifies the solution. On this basis it is quite obvious that if the distance from the sampson post bearing to the pitman bearing equals the distance from the sampson post bearing to the polished rod hanger bearing that the vertical reaction at *P*, the sampson post bearing, will be twice the polished rod load. Likewise if the vertical component of the pitman load equals the polished rod load the vertical reaction on the crank bearing O will be equal to the rod load. This last conclusion assumes that the power is supplied to the crank by a pure torque such as in the case of a well driven by a motor through a speed reducer connected by a flexible coupling. If the crank is driven through a countershaft with a belt the reactions will depend upon the belt load and position.

It is quite obvious that the horizontal component set up because of the angularity of the pitman acts directly on the bearing at *P* and an equal and opposite horizontal reaction at O results except for the case mentioned in the previous paragraph.

When the curves for vertical and

[1] "Fundamentals of Well Counterbalancing" by Emory N. Kemler, *The Petroleum Engineer*, May, 1936.

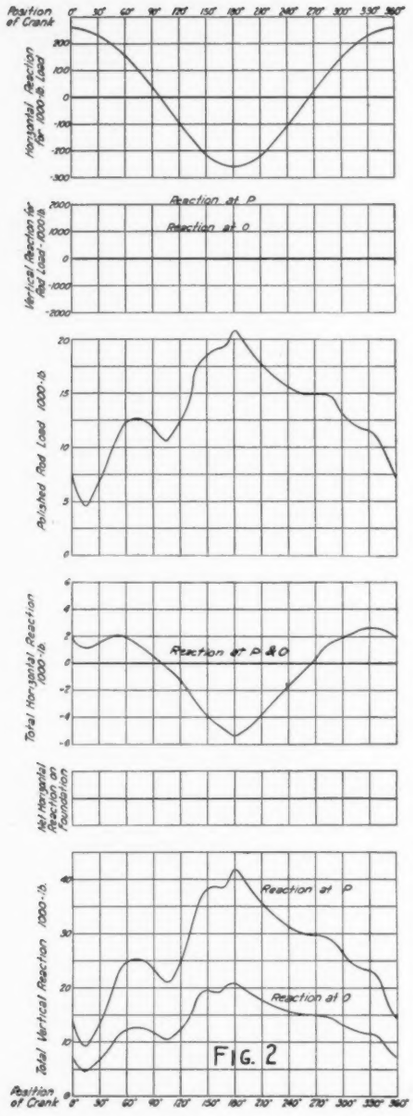

FIG. 2

horizontal reactions for 1000-lb. load have been constructed it is only necessary to multiply the actual load in thousands of pounds at any position by the values calculated above for 1000-lb. load.

The horizontal reactions for *P* and *O* are shown for this case and it will be seen that they have the same magnitude; but since one is the reaction of the other one, they will have opposite signs. For the direction of rotation shown it is seen that on the downstroke of the pump, which covers the crank positions from 270 deg. to 90 deg., the pitman, being in tension, causes the part of the foundation between the sampson post and crank to be placed in compression and during the upstroke of the pump it will be in tension.

If the foundation is rigidly connected there will be no net horizontal shaking force, because the horizontal components from *P* and *O* cancel each other. There is of course a net vertical reaction. The reaction at *P* being downward and at *O* upward, results in a net downward force equal to the rod load and a turning moment equal to the polished rod load times the horizontal distance from the polished rod bearing to the sampson post bearing. The values of the reactions for this case are shown in Fig. 2.

B. Beam Counterbalance (Fig. 3)

The reactions in the case of a beam-counterbalanced well are found by superimposing the reactions for the counterbalance upon the reactions found for the case of no counterbalance. In this case the reactions have been worked through for 1000-lb. weight at the end of the walking beam.

As was pointed out previously, this 1000-lb. weight does not exert a constant force. The force is given by

$$F = W + \frac{W}{g}a.$$

A curve for vertical reaction has been plotted for 1000-lb. weight with its center of gravity above the pitman bearing and is shown in Fig. 3. The vertical reaction at *P* will of course depend on where the counterweight is placed. If the center of gravity of the counterweight is over the pitman bearing the reaction at *P* will be the same as without the counterbalance. The horizontal reaction caused by the 1000-lb. weight has been plotted (Fig. 3). It will be noted that both the horizontal and vertical reactions at *O* have a negative sign as compared with the reactions for 1000 lb. of polished rod load. This is because the counterweight is replacing part of the vertical force required at the pitman bearing to balance the polished rod load. Thus when these values are added to the values for the case without counterbalance smaller reactions will in general be obtained.

In the curve for the reactions at *O* (Fig. 3) for the case of 10,000-lb. beam counterbalance it is seen that during the downstroke of the pump (270 deg. to 90 deg.) the vertical reaction at *O* changes sign. This is because the pitman is in compression during a part of the cycle. It will be noted that the horizontal reaction at *O* is much less than for the other cases. This means that the part of the foundation between the sampson post and crank bearing will always be under a lower stress than for the other cases. Again it will be noted that there is no net shaking force on the foundation for the reasons previously mentioned.

C. Rotary Counterbalance (Fig. 4)

The curves for total reactions have been figured on the basis of using 1000 lb. of rotary counterbalance with its center of gravity at a radius of three feet. The curves for horizontal and vertical reactions for 1000 lb. of counterbalance have been constructed on the assumption that the crank speed is constant (see Fig. 4). While we know that this assumption is not correct, lack of data on the actual speed makes it impossible to make the calculations on any other basis. The curves for the total horizontal reaction at *O* and *P* show that the rotary counterbalance reduces the horizontal reaction at *O* but does not affect the reaction at *P*. It shows that the load in the foundation between the sampson post bearing and the crank bearing varies in direction as well as magnitude. The curve for vertical reaction at *O* shows that the maximum vertical reaction at *O* is not reduced below that for the case of no counterbalance. It will be noted that there is in this case a net horizontal shaking force. This force is equal to the horizontal shaking force set up by the rotating counterweight.

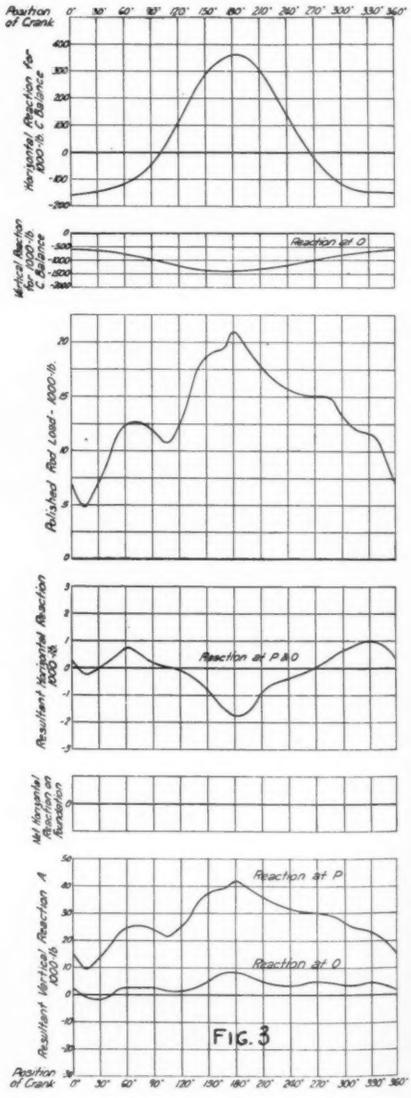
Position of Crank
Horizontal Reaction for 1000-lb. C'balance
Vertical Reaction for 1000-lb. C'balance
Reaction at O
Polished Rod Load - 1000-lb.
Resultant Horizontal Reaction 1000-lb.
Reaction at P & O
Net Horizontal Reaction on Foundation
Resultant Vertical Reaction 1000-lb.
Reaction at P
Reaction at O
Position of Crank

FIG. 3

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"OLD FAITHFUL"—Photo courtesy of Burlington Route

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D. Comparisons

A comparison of the reactions for the three conditions of counterbalance under which wells operate will be made by comparing the values at each bearing. The vertical reaction at *P* is the same regardless of the amount of counterbalance. It must be remembered that the reaction at *P* for the case of beam counterbalance depends upon the position of the counterbalance. The vertical reaction at *O* is different for the three cases. The peak load for the rotary weight is the same as for the case of no counterbalance but the load at any other position is different for the two cases. The maximum vertical reaction at *O* for the case of beam counterbalance is about 25 percent less than the value for the other two cases.

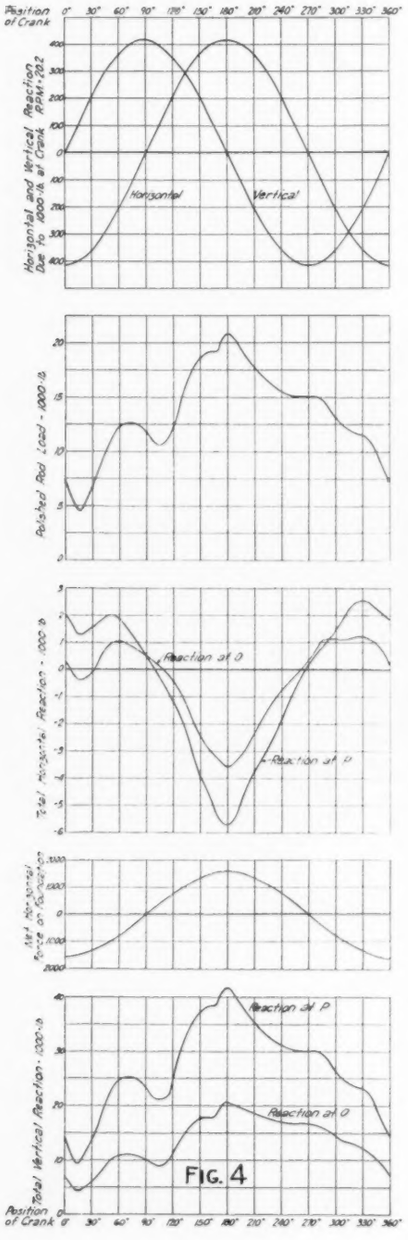

FIG. 4

The reaction at *O* for this case changes direction during the cycle and for the other two cases, it always has the same direction. In the case the crank or bearing at *O* is designed to take a variation in direction of load the lower vertical reaction means lower bearing loads. If however, the bearing has excess clearance the reversal of direction of the load may cause the bearing to be noisy. These remarks apply also to the pitman bearings since the vertical component at *O* is the vertical component of the pitman load.

The horizontal reaction at *O* and *P* will not affect the operation unless the foundation is not rigidly tied together. Under these conditions the variation of the load and the fact that they are opposite in direction might in time cause damage to the foundation.

Only in the case of rotary counterweight is there a net horizontal force on the foundation. For non-rigid or insecure foundations the side shake combined with the variation in vertical reaction may cause the foundation to work loose or fail.

Effect of Counterbalance on Stresses on the Crank Shaft

The design of the crank shaft is usually determined by the overhung crank load rather than the gear or belt load. Since this load overhangs the bearing, the shaft will be subjected to both tension and torsion. The maximum stress will be the resultant of these two components when reduced to an equivalent bending or torsional stress. The formula for calculating this resultant stress can be written either in terms of the resultant bending moment or torque. Writing it in terms of the resultant or equivalent bending moment we have:

$$M_e = M^2 + T^2$$

Where M_e is that bending moment which would give the same effect as the combined bending and torsion

M = actual bending moment

T = torque at same time as M is measured

Figs. 5a, 5b, and 5c show schematically the general arrangements to be considered for each case.

A. Beam Counterbalance

For the case of a beam counterbalance, the vertical component of the pitman pull, *P*, will be equal to the polished rod load, *L*, less the effective counterbalance or:

$P = (L - W_e)$

L = polished rod load

W_e = effective counterbalance

The torque on the shaft will be given by:

$T = P \times R$

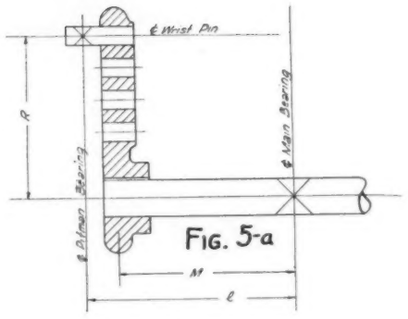

FIG. 5-a

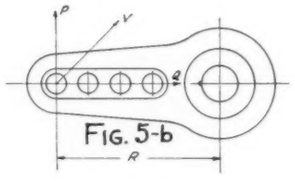

FIG. 5-b

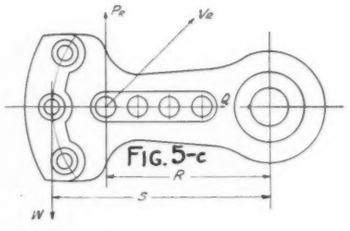

FIG. 5-c

Actually, the maximum bending moment will be equal to the pitman pull *V* times 1 (neglecting weight of crank). This will be little different from the vertical component. If this simplification is not made the problem becomes unnecessarily complicated as it becomes necessary to make a layout drawing for a number of positions to determine where *V* is a maximum. This simplification can also be considered as neglecting the horizontal component of the pitman pull on the stresses in the shaft. Using this simplification we have that the maximum bending moment is given by $P \times 1 = (L - W_e)\ 1$. The resultant bending moment will be:

$$M_e = \sqrt{(P\,1)^2 + (P\,R)^2}$$

$$= P\sqrt{1^2 + R^2}$$

$$= (L - W_e)\sqrt{1^2 + R^2}$$

This equation shows that with no counterbalance the stress in the shaft will be much higher than with counterbalance since $W_e = O$ for the case of no counterbalance.

B. Rotary Counterbalance

The vertical component of the pitman pull will in this case be equal to the polished rod load (assuming the beam pivoted in its center), and if *W* is the amount of rotary counterbalance used we have that the bending moment will in this case be equal to:

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$$M = P_R \times 1 - W \times M = (L\,1 - W m)$$

The torque will be given exactly by:

$$T = P_R\ R - W\ S = LR - WS$$

If the effective counterbalance is the same for the rotary and beam counterbalances we would have:

$$WS = W_c R \text{ or } W = \frac{W_c R}{S}$$

$$T = LR - W_c R = (L - W_c)\ R$$

$$M = L1 - \frac{W_c R}{S} M$$

and for the rotary counterbalance

$$M_e = \sqrt{(L\,1 - \frac{W_c R}{S} M)^2 + (L - W_c)\ R^2}$$

C. Comparison

A comparison of the equation for the beam and rotary counterbalances shows that the equivalent bending moment for the case of the rotary weight will be greater than that for the beam weight. This is because the type of construction necessary makes the lever arm of the rotary weight less as far as balancing bending moment is concerned and the longer distance to the center of gravity of the rotary weight also makes its actual weight less than its effective weight. When bending moment is concerned, the actual weight must be considered. The beam weight, therefore, proves several advantages as far as stresses and shaking forces are concerned.

Automatic Auxiliary Drip For Gas Wells

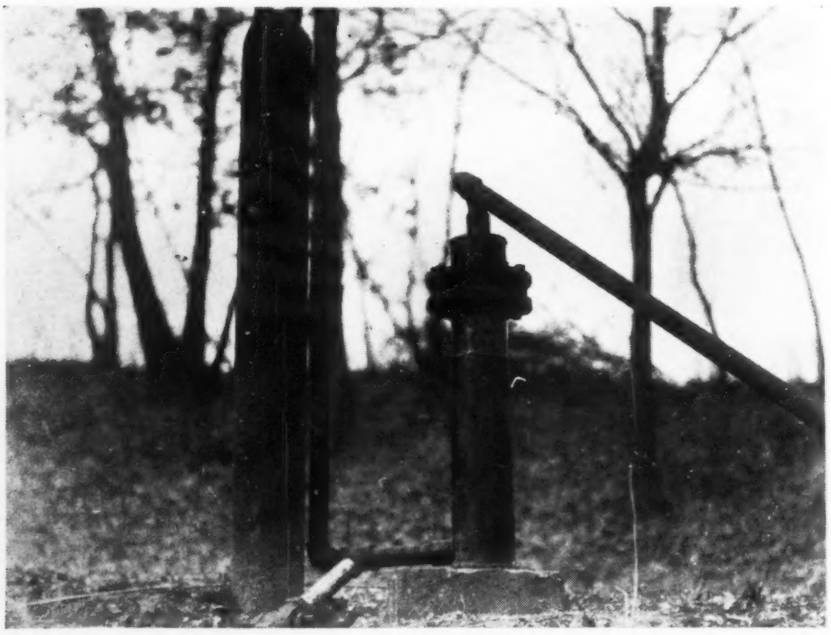
By ROY W. PARKER
Oklahoma Natural Gas Company

GAS companies operating systems where the winter temperature is below freezing much of the time not infrequently have their gas service interrupted by freeze-ups. The cause of this trouble usually can be traced to some one or several wells that are chronic offenders or to the fact that the immediate peak load requirements are being pulled to capacity. Trouble from these causes results in water coming over with the gas in such quantity that the existing drip facilities can not handle the excess water, allowing it to get into the main line where it freezes and causes all wells back of the point of water entry into the main line to be cut out.

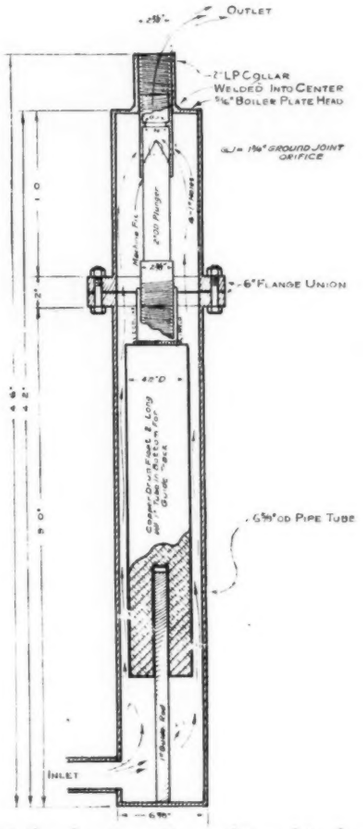
A simple automatic auxiliary drip that cuts out offending wells of this type has been devised by J. A. McNally, operating manager of gas properties in Oklahoma and Kansas, for the Oklahoma Natural Gas Company. An installation of the drip in the field and also a drawing of the internal arrangement of the drip itself are shown in the accompanying illustrations.

The operation of the drip is very simple but positive. The water fills the main drip and as more water continues to come from the well it is forced into the auxiliary drip until the float rises and shuts the well off. No more gas from that particular well is fed into the line until the auxiliary drip discharges, which it does automatically and without any water getting into the main line.

Several of these drips are in operation and have proven their worth on wells of the type for which the drip is designed. They can be used on wells that produce water gradually or produce large amounts intermittently. The drip does not seem to be adaptable on wells that drown out if shut in for a considerable period.



Installation of automatic auxiliary drip at a gas well



Details of automatic auxiliary drip for controlling water from gas wells

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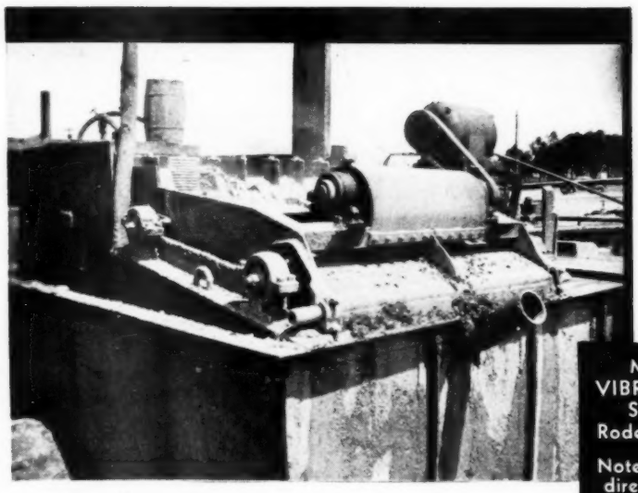

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JUNE 30, 1936

RESOURCES

Cash and Due from Banks	$23,911,990.52	
U. S. Government Securities	16,670,722.02	
Other Bonds and Warrants	4,542,141.51	$45,124,854.05
Loans and Discounts		15,589,555.26
Overdrafts		3,375.76
Income Receivable Accrued		161,682.11
Stock in Federal Reserve Bank		240,000.00
Investment in Bank Premises		2,251,000.00
Customers' Liability under Acceptances		5,393.25
TOTAL		$63,356,060.43

LIABILITIES

Deposits		$54,618,680.95
Acceptances Executed		5,393.25
Income Collected not Earned		81,768.75
Interest, Taxes, etc., Accrued		86,071.34
Capital—Preferred	$ 4,000,000.00	
Capital—Common	2,000,000.00	
Surplus	2,000,000.00	
Undivided Profits and Reserves	604,146.14	8,604,146.14
TOTAL		$63,356,060.43

COMPARATIVE DEPOSITS

June 30, 1933	$27,517,143.20
June 30, 1935	40,250,985.50
June 30, 1936	54,618,680.95

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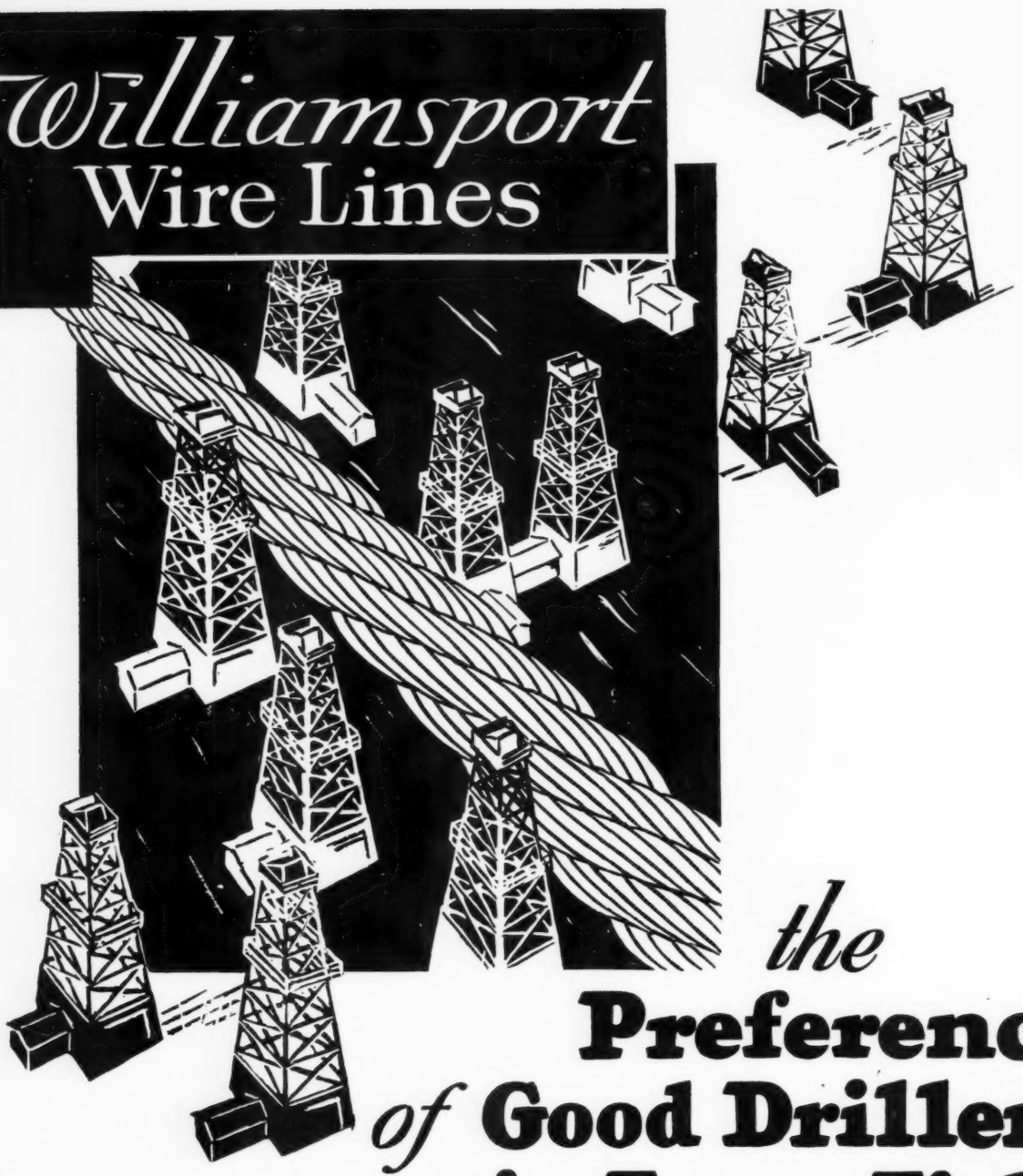

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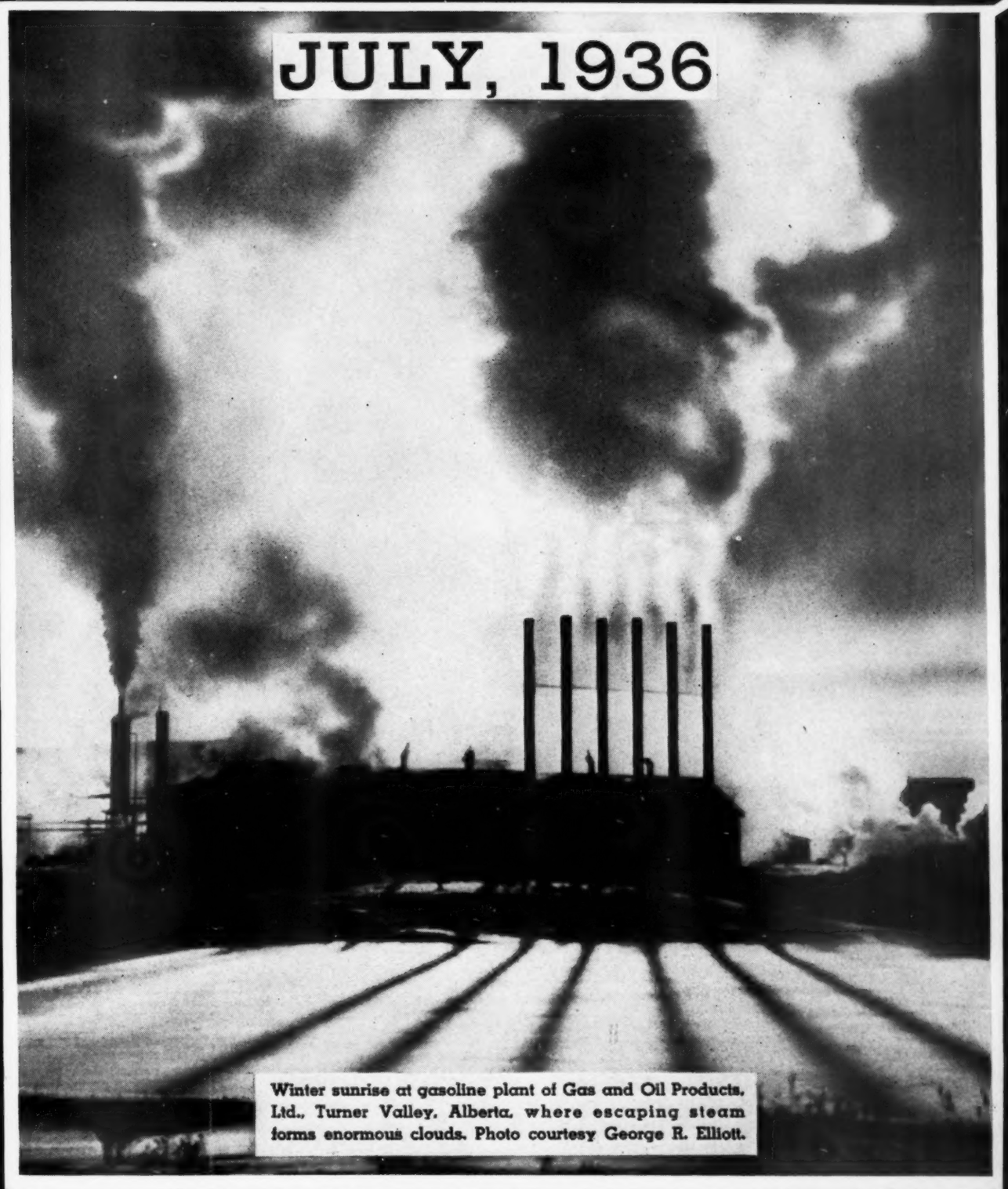
PETROLEUM

JULY, 1936

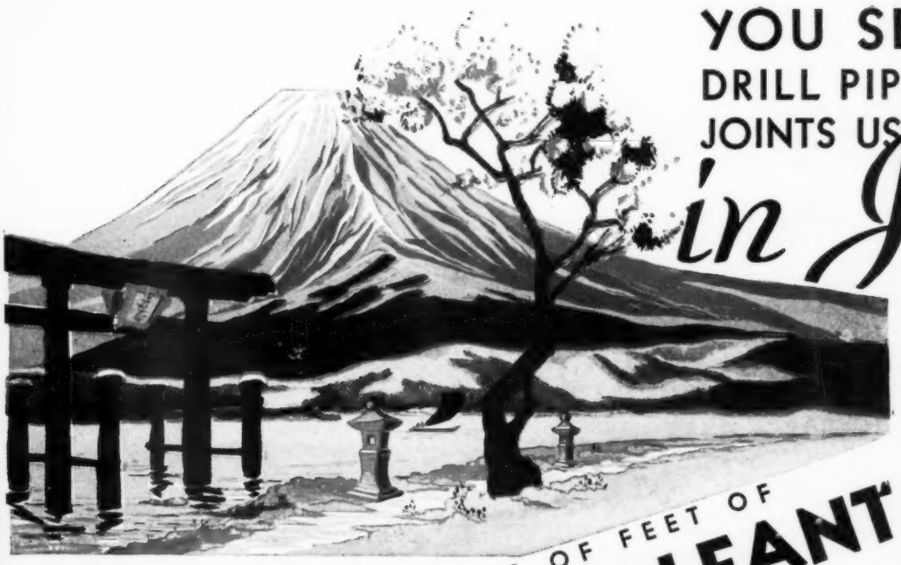


Winter sunrise at gasoline plant of Gas and Oil Products, Ltd., Turner Valley, Alberta, where escaping steam forms enormous clouds. Photo courtesy George R. Elliott.

A REGULAR FEATURE OF THE PETROLEUM ENGINEER

1. P. C. Wade, production superintendent for Shaw Oil Company, Houston, Texas.
2. George H. Echols, drilling contractor, Houston, Texas.
3. Brian Mead, research engineer for the Humble Oil & Refining Company, Houston, Texas.
4. J. Zaba, chief engineer for the Rio Bravo Oil Company, Houston, Texas.
5. Marvel No. 1 well of Sinclair-Prairie Oil & Gas Company in Cleveland County, Oklahoma, said to be one of the largest wells in the Mid-Continent, having a potential of 48,000 bbl. with 2300 lb. casing pressure.
6. Franklin No. 1 well of Sinclair-Prairie et al., the first well drilled in the Cleveland County, Oklahoma, field. Finished as a gas well, it later was deepened to 7318 ft., producing from the Wilcox Sand with an estimated potential of 35,000 barrels.

YOU SEE HYDRIL DRILL PIPE AND CASING JOINTS USED EVERYWHERE *in Japan*



THOUSANDS OF FEET OF

SPANG-CHALFANT DRILL PIPE and CASING

Equipped with these

HYDRIL DRILL PIPE and CASING JOINTS

ARE IN USE BY JAPANESE OPERATORS

HYDRIL EXTERNAL FLUSH DRILL PIPE JOINT (PATENTED)

HYDRIL INTERNAL FLUSH DRILL PIPE JOINT (PATENTED)

EXTERNAL FLUSH DRILL PIPE JOINT
The only **double-purpose** drill pipe joint. Best for ordinary drilling work—indispensable for pressure drilling.

INTERNAL FLUSH DRILL PIPE JOINT
The size of the hole through the tool joints is the same as the full inside diameter of the drill pipe in all sizes from 2⅜-inch up.

INTERNAL AND EXTERNAL FLUSH CASING JOINT
Can be run through set packers with ease and safety. Absence of projecting couplings permits a larger size casing to be set in a hole of given size.

All pipe manufacturers make pipe for Hydril Drill Pipe and Casing Joints. Write for full engineering details and refer to your 1936 Composite Catalog.

HYDRIL INTERNAL AND EXTERNAL FLUSH CASING JOINT (PATENTED)

HYDRIL

HYDRIL COMPANY
714 West Olympic Blvd. • Los Angeles
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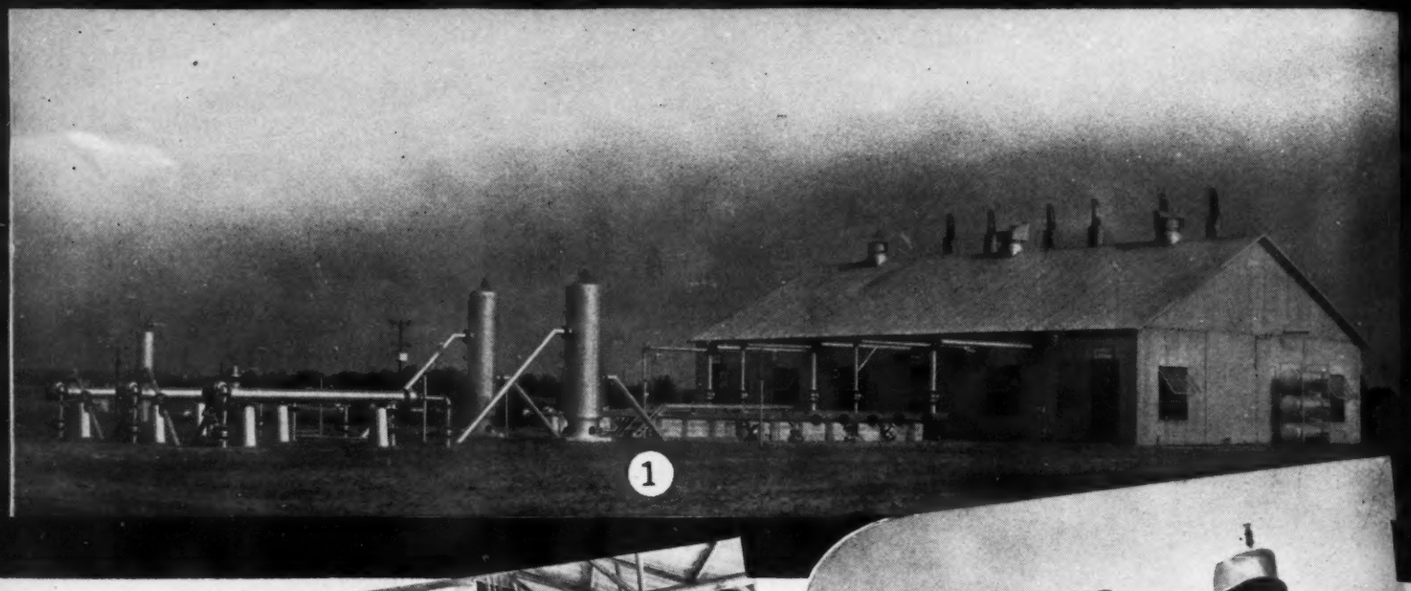
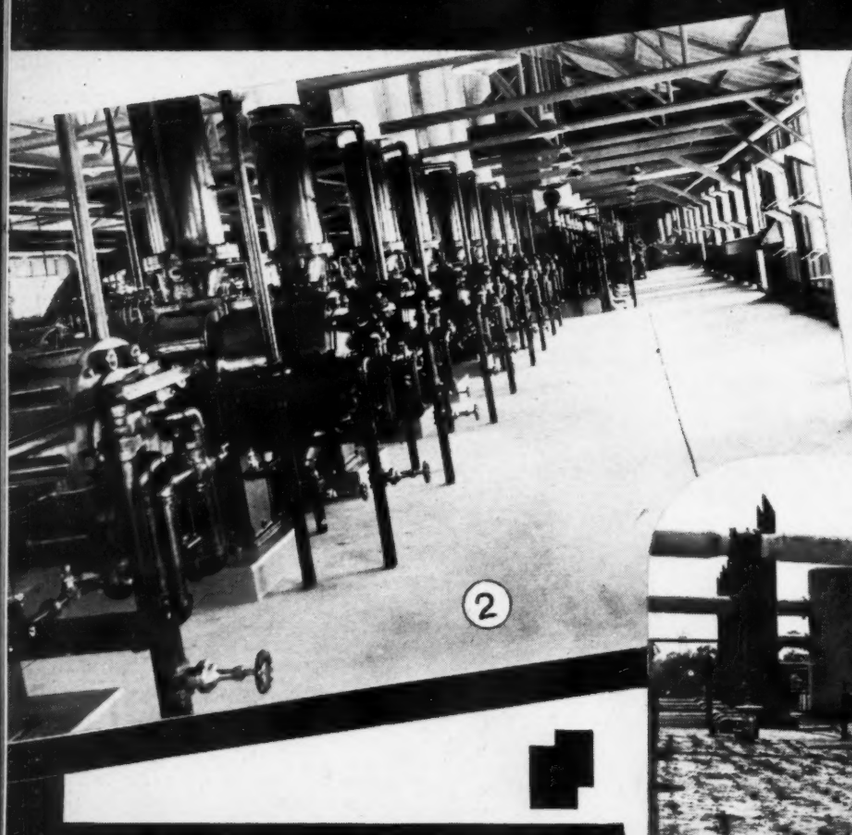
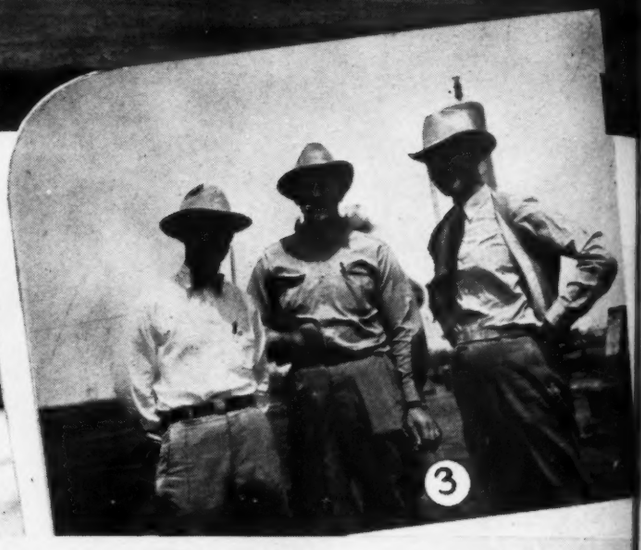
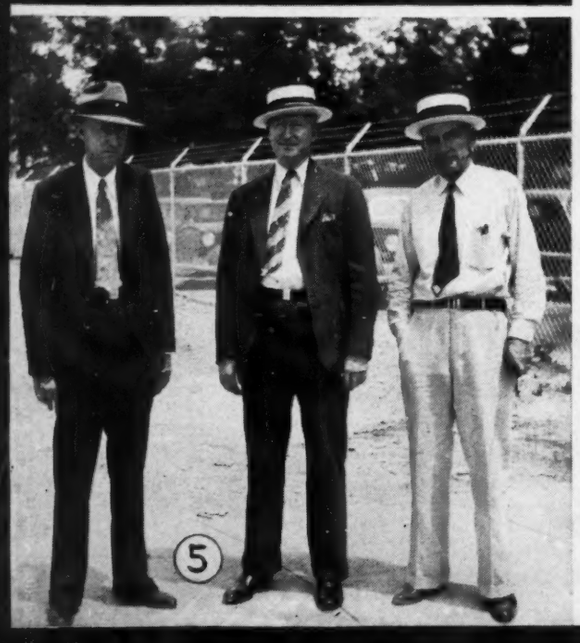
Cable Address—"HYDRIL"









1. E. H. Moore's new pressure plant at Ada, Oklahoma. It contains three Type-12 twin Cooper-Bessmer compressing engines and is at present being used for drilling wells in under pressure. Later the plant will be used for gas lift work.
2. Power end of compressor units at the Gregg Tex Gasoline Corporation plant near Longview, Texas.
3. Snapped at Texon, these three men are familiar figures in West Texas oil activity. Left to right: R. H. Washburn, engineer for Gas Lift Sales Corporation; C. M. Thomas, assistant petroleum engineer for Big Lake Oil Company; and C. R. Johnson, general superintendent for Big Lake Oil Company.
4. Vacuum scrubbers at the Gregg Tex Gasoline Corporation plant, Longview.
5. This photograph, taken in the Rodessa, Louisiana, field shows, left to right, F. L. Rhoades, superintendent of gasoline plants, United Gas Public Service Company; W. F. Fulton, chief chemist of the United; and Wm. H. "Jack" Vaughan, general superintendent of Pelican Oil and Gasoline Company, Inc.

HYDROPRESS

High Head,
Low Capacity, Non-Pulsating Flow

Left, Steam turbine drive Hydropress, 50 GPM, 800 foot head, 210° F.
Right, Electric motor drive Hydropress, 100 GPM, 540 foot head, 100° F.

THE oil industry has adopted the Byron Jackson Hydropress for process work in refineries, boiler feed service, the repressuring of oil wells, and for numerous other purposes where low capacity and high heads are determining factors. The Hydropress is available powered either by explosion-proof or totally enclosed, fan-cooled electric motor or steam turbine, fully automatic or manually operated. For refinery service the Hydropress is capable of handling 300 to 7000 barrels per day at temperatures up to 900 degrees F., and at pressures exceeding 2500 pounds per square inch. It requires but a fraction of the floor space used by horizontal pumps. Simple in design and completely trouble-free. In four standard sizes: 8", 10", 12" and 15". Send for Bulletin 357.

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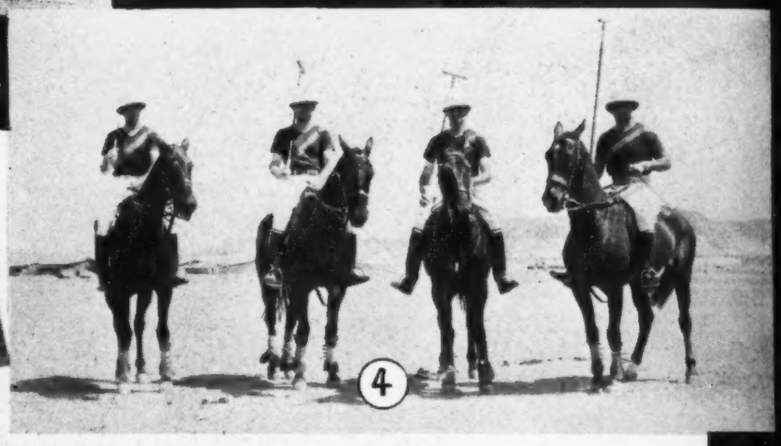
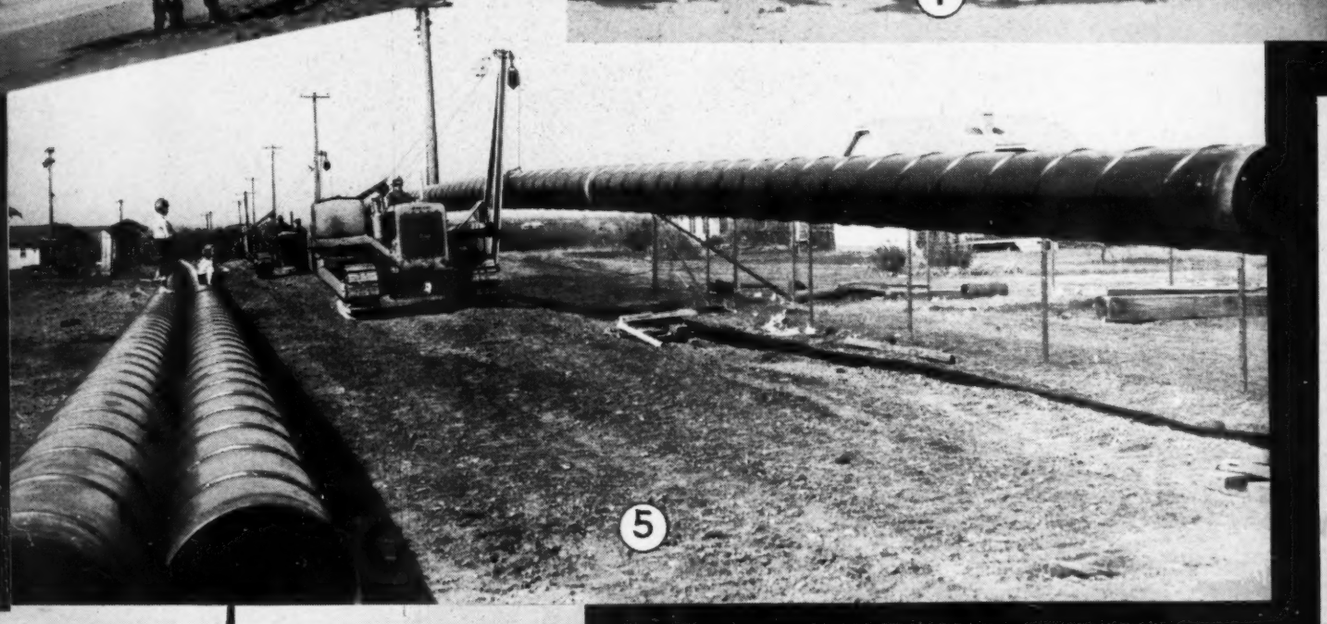
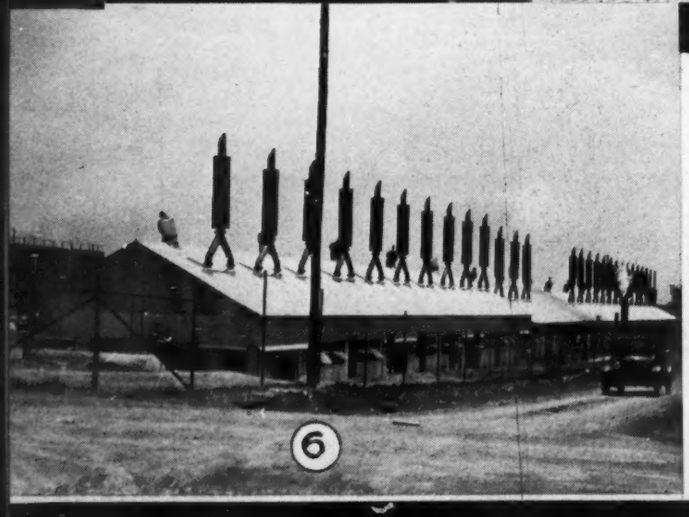
CENTRIFUGAL PUMPS FOR EVERY SERVICE

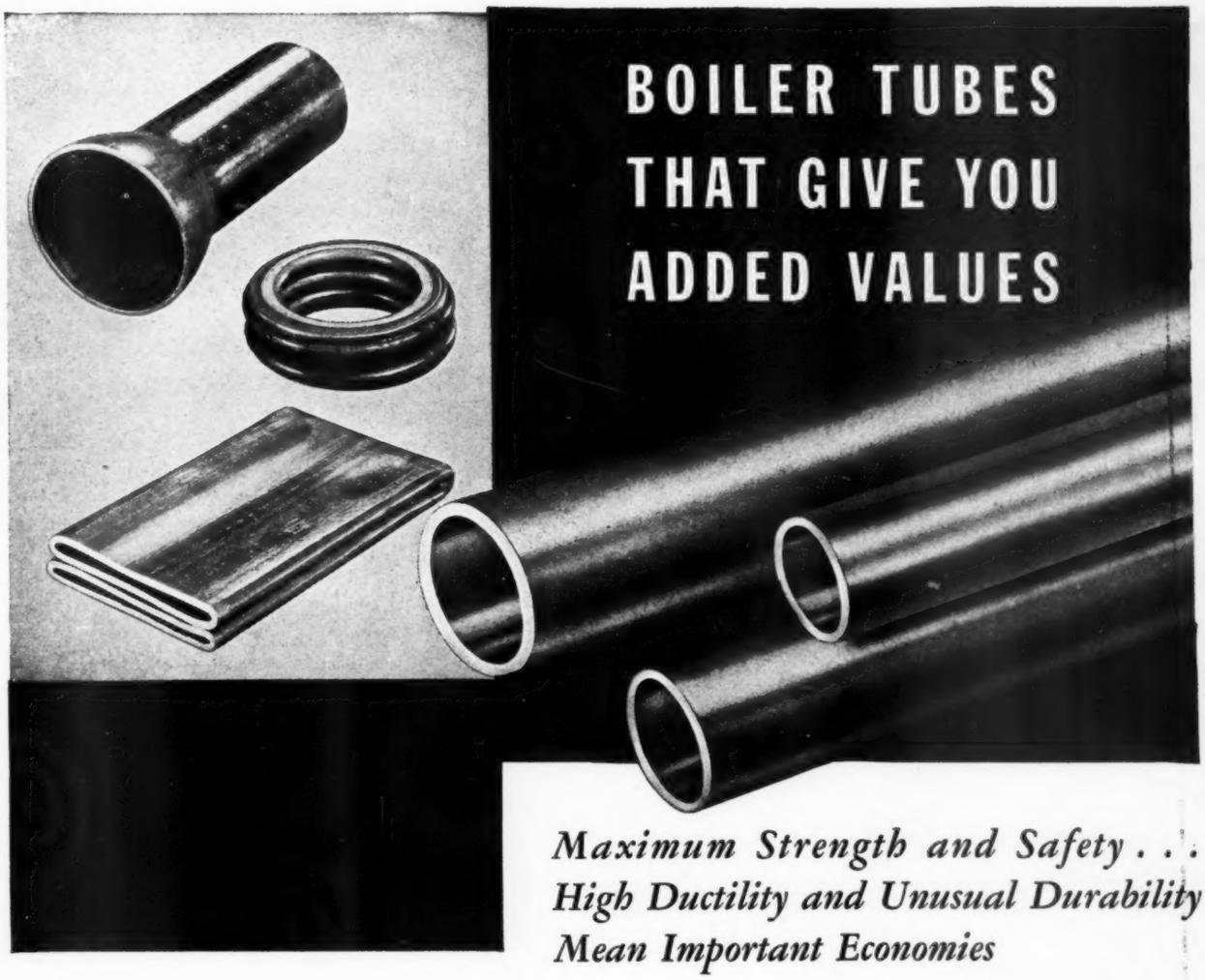






The four photographs grouped at the top of the page were obtained from Bart A. Myers of International Petroleum Company, Ltd. They are of interest to oil men because of the fact that the star player of the polo team shown is Art Iddings, general manager of International Petroleum Company of Peru. Representing the Talara Polo Club, the team uniformly gives a good account of itself against all comers in their section of South America.

1. Left to right—J. Neville, Art Iddings, C. Kindersley and W. White.
2. Mrs. Art Iddings and the exceptionally fine string of ponies of the Talara Polo Club.
3. Art Iddings himself.
4. The team mounted and ready for action. Left to right—Neville, Iddings, Kindersley and White.
5. Caterpillar Diesel RD6 equipped with a Cardwell side boom handling 200 ft. sections of 24-in. pipe for Truman-Smith Construction Company at Oklahoma City.
6. New Capitol booster station of Phillips Petroleum Company at Oklahoma City. Installed in it are 30 230-horsepower Clark Bros. compressor units.



BOILER TUBES THAT GIVE YOU ADDED VALUES

Maximum Strength and Safety . . .
High Ductility and Unusual Durability
Mean Important Economies

When you use J & L Hot Rolled Seamless Steel Boiler Tubes you are assured of many *added* values. Because of their high ductility, installation is economical. These tubes are easily formed, expanded and beaded in cold, without splitting or fracturing. Dependable strength and safety mean trouble-free performance over a long period of time, thereby reducing repairs and maintenance to a minimum, and saving you costly tie-ups of other expensive equipment.

J & L Hot Rolled Seamless Boiler Tubes are pierced from solid billets of selected high quality steel. *There can be no failure at a weld because there are no welds.* The process by which J & L *seamless* tubes are manufactured increases the strength, toughness and workability of the steel in the finished product. Inspections during every stage of manufacture assure uniform, superior quality tubes that give long life and lasting satisfaction. A full range of sizes is available, from 1-inch o.d. to 6-inch o.d. inclusive.

Leading oil producers and refiners, railroads, shipyards, operators of large steam plants, boiler manufacturers and boiler repair shops use J & L Hot Rolled Seamless Boiler Tubes for both fire tube and water tube types of boilers. They all testify to their many advantages.

The next time you buy, specify J & L Hot Rolled Seamless Boiler Tubes.

J & L Hot Rolled Seamless Boiler Tubes are manufactured in accordance with the A.S.M.E. Boiler Code and comply with the A.S.T.M. Specifications and the United States Bureau of Navigation and Steamboat Inspection General Rules and Regulations.

OTHER J & L PRODUCTS FOR THE PETROLEUM INDUSTRY

Seamless drill pipe, casing, tubing, and line pipe; steel for derricks and other structural purposes; tinplate for containers; tank barges; and bars, shapes, plates, steel piling, concrete reinforcing bars, wire and nails for maintenance and construction.

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AMERICAN IRON AND STEEL WORKS
JONES & LAUGHLIN BUILDING, PITTSBURGH, PENNSYLVANIA

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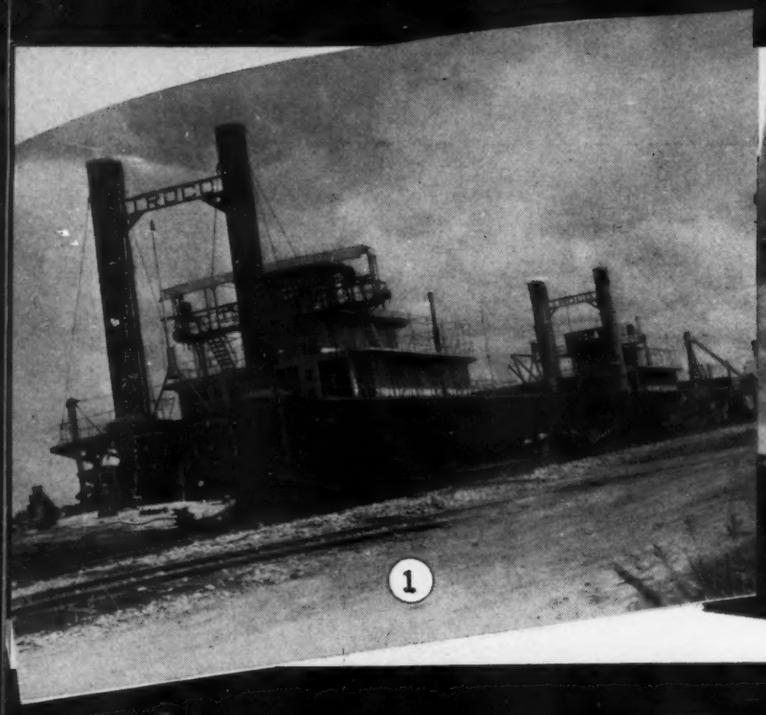
*Operated by National Bridge Works Division of Jones & Laughlin Steel Service, Inc.
Canadian Representation: JONES & LAUGHLIN STEEL PRODUCTS COMPANY, Pittsburgh, Pa., U. S. A., and Toronto, Ont., Canada

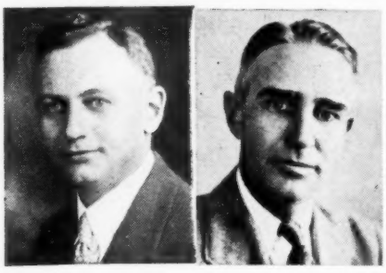


South American views appearing on this page are reproduced through courtesy of Bart A. Myers, an official of International Petroleum Company, Ltd., Toronto, Canada.

1. Along the river front at Galan—boats of the Tropical Oil Company.
2. Partial view of the La Cira gas plant of Tropical Oil Company.
3. Barranca swimming pool. First-class staff bachelor mess hall at rear.
4. The Tenth Hole at El Centro.
5. The Barranca refinery of Tropical Oil Company showing run-down tanks in the foreground. The distillation units, including crude topping plant, two-stage distillation unit (under construction) and lubricating oil plant are in view.

RUNNING TOUR With Men In The Industry

ELMER F. SCHMIDT, general superintendent of the Lone Star Gas Company, Dallas, Texas, has been made a vice-president of the company



ELMER F. SCHMIDT JULIAN L. FOSTER

and placed in charge of all production and transmission system activities. **JULIAN L. FOSTER,** chief engineer, has been made general superintendent and will perform the duties of that position as well as continuing those of chief engineer.

P. S. (PETE) HAURY has returned to the United States from Korea, where he has been engaged in mining for the last four years. He plans to resume work in the Mid-Continent fields as petroleum engineer and geologist.

W. H. STUEVE, in charge of oil industry power sales for the Oklahoma Gas and Electric Company, Oklahoma City, has received a professional degree as mechanical engineer from Ohio State University. The honor was conferred in recognition of Stueve's work in devising and improving the use of electric power in the oil transportation industry.

R. H. MORRISON, general manager of The California Company, affiliate of the Standard Oil Company of California, with headquarters at Dallas, Texas, has been made vice-president of the newly-formed California Texas Oil Company, Ltd.

HUGH ROY CULLEN, well-known operator of Houston, Texas, has been honored with a Doctor of Science degree by the University of Pittsburgh.

R. B. WHITEHEAD, chief geologist of the Atlantic Oil Refining Company, Dallas, Texas, died July 1st at the Grace Hospital, Detroit, Michigan, following an emergency operation. He had been ill for some time. Whitehead was prominent in activities of the oil fraternity and has a host of friends throughout the industry who will be saddened to hear of his passing.

J. D. CREVELING of New York, engineering executive of the Cities Service Company, has been named president of the Panhandle Eastern Pipe Line Company. He has been a Cities Service Company executive in New York since 1918, when he was transferred there from the offices of the Empire Companies at Bartlesville, Oklahoma.

F. F. HILL, who has been director of production for the Union Oil Company of California, has been made a special representative of the company, having as his duties the acquisition of lands and the management of production outside the state of California. **A. C. RUBEL,** manager of field operations, takes over Hill's old post as director of production. Hill has been with the Union Oil Company since 1895, although for a brief period he severed his connection, returning later. Rubel first entered the employ of the company in 1923.

F. F. HILL

DALE NIX returned recently to the United States from Bahrein Island in the Persian Gulf, where he has been for the last three years engaged in oilfield development operations. Nix was petroleum engineer with The California Company in West Texas before his assignment to the Persian Gulf field with the Bahrein Petroleum Company, Ltd.

CLYDE R. VINTON, superintendent of the Michigan producing division of the Pure Oil Company, who passed away recently, was well known throughout the entire petroleum industry. Death followed an illness of five months, during a part of which time he was confined to a Saginaw hospital. He had been associated with the Pure Oil Company since 1916.

W. R. REED has been made general superintendent of the Sinclair Prairie Pipe Line Company and will have his headquarters at Independence, Kansas. Formerly assistant to the president, **J. R. MANION,** Reed assumes the position occupied by **J. F. BLAKE** until his recent death. **W. E. MORRISON** has been appointed assistant general superintendent with headquarters in Tulsa, Oklahoma. He has been division superintendent at Shawnee, Oklahoma. **B. M. HORSLEY,** who has been connection foreman at Oklahoma City, has been made district foreman at Shawnee.

E. H. LEROUX, president of the Oklahoma Pipe Line Company, with headquarters at Tulsa, Oklahoma, has retired from active service. He is succeeded by **WALLACE R. FINNEY,**

W. R. FINNEY

who has been chief engineer of the production department of the Standard Oil Company of New Jersey. Finney will be in charge of operations of the Oklahoma Pipe Line Company and the Ajax Pipe Line Company in the Mid-Continent area. Leroux has been with the company since 1909, and has been its president since 1926.

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

Hubby: The bank has returned that check.

Wife: Isn't that splendid! What can we buy with it this time?

* * *

"What model is your car?"

"It's not a model; it's a horrible example."

* * *

Moses kept a secondhand clothes shop, and on leaving it in charge of his son Ikey during the dinner hour imparted to him the fact that on the price ticket one dot represented one dollar, two dots two dollars, and so on.

Returning, Moses inquired of his son:

"Haf you had any customers, Ikey —vat?"

"Yes, Fader, I have sold de grey coat and vest for eight dollars."

"Vell, vell, now, you did goot business, for it was only five dollars."

"No, Fader, I kept the ticket; see, it has eight little dots here."

The old Jew scratched his head, and smilingly remarked:

"Jubilee Jerusalem! I vil never kill anoder fly."

* * *

Pat: That was a foine sintiment Casey got off at the banquet last night.

Mike: What was it?

Pat: He said that the swatest mimories in loife are the ricollections of things forgotten.

* * *

Boy: Say, dad, what does it mean when the paper says some man went to a convention as a delegate-at-large?

Dad: It means his wife didn't go with him, son.

* * *

Cop: Say, do you realize you were going sixty-five miles an hour?

Sweet Young Thing: Sixty-five! Don't be silly! I couldn't have been going over 30 at the most. In fact, I don't believe I was going more than 25 at the outside.

Cop: Well, maybe you're right. I'll just tear this ticket up and give you one for parking.

* * *

"Jack is so original. He says things to me that no one else would dream of saying."

"What's he been up to now—asking you to marry him?"

A racketeer on trial for murder bribed an Irishman with $100 to hold out for verdict of manslaughter. After being out for a long time, the jury returned the desired verdict.

"I'm very grateful to you," the racketeer told the Irishman.

"Did you have much trouble?"

"Yes," replied the son of Erin, "I had a devil of a time. All the rest wanted to acquit you."

* * *

An old maid of our acquaintance says she had a most shocking experience the other evening. According to the way she tells it, she was sitting out on the back porch along about dusk with her cat purring contentedly beside her when a strange man came up the walk, entered without knocking, and pulled her into his arms.

"He was a near-sighted man," she says, "and he mistook me for his sweetheart. It was all of two hours before he discovered his mistake!"

* * *

It was three o'clock in the morning. The car stopped in front of the small apartment house and out stumbled two lads, both beautifully boiled. Between them they held a young lady who was also well boiled.

Up to the door staggered the three. One of the boys began to pound loudly on the door. A ritzy-looking dame stuck her head out of the second-story window.

"What's the reason for the noise at this unearthly hour?" she demanded angrily.

One of the lads gazed upwards.

"Lady," he hiccoughed, "you better come down and get your daughter. She'sh stewed."

The woman grew highly indignant.

"I'll have you understand, young man," she snapped haughtily, "that isn't my daughter. I carried my daughter up half an hour ago!"

—*Whiz Bang.*

* * *

Pity Pater

Little Martha in the attic
Found her mother's automatic.
Then, in simple childish glee,
Popped the iceman in the knee.
Mother whined, "Gosh, what a bother.
Why, he might have been your
father!'"—*Penn Punch Bowl.*

A group of golfers were telling tall stories. At last came a veteran's turn.

"Well," he said, "I once clubbed a ball (accidentally, of course) through a cottage window. The ball knocked over an oil lamp, and the whole place caught fire."

"What did you do?" asked his friends.

"Oh," said the veteran, "I immediately teed another ball, took careful aim, and hit the fire alarm in the next street. And that brought out the firemen before any damage was done."

* * *

Wife: Paul, this suit is very shabby. May I give it away?

Husband: Heavens, no! That is the suit I go to protest against my tax assessment in.

* * *

The young apprentice was whistling merrily.

"Stop that!" shouted the foreman. "You mustn't whistle while at work."

"Who's working?" queried the apprentice.

* * *

"Aren't you afraid the birds will eat your seeds? You ought to put up a scarecrow."

"Oh, it's not worth it. There's always one of us in the garden."

* * *

"Is there any ladies' maid in this town?"

"Yeah, but you don't mean 'is'."

* * *

Customer: This is a very small steak you gave me.

Waitress: Yes, sir; but it will take a long time to eat it.

* * *

"It's being rumored around that you and your husband are not getting along very well together."

"Nonsense. We did have some words and I shot him, but that's as far as it ever went."

* * *

"What did you leave your job for? I thought you had a good thing there."

"I thought so, too, till I'd been there a week. I was supposed to be secretary to the vice president, but he was no vice president at all. Why, he only took two hours and a half for lunch, and sometimes he'd stick around till four in the afternoon. I couldn't work for a man like that."

WILL IT SAFELY GUIDE AND FLOAT MY CASING?
WILL IT DISTRIBUTE THE CEMENT COMPLETELY AROUND THE CASING?
WILL THE VALVE HOLD CEMENT IN PLACE?
FLOAT
BAKER CEMENT WHIRLER FLOAT SHOE
WILL THE CONCRETE PLUG AND BAKELITE BACK-PRESSURE VALVE DRILL UP EASILY?
When you "whirl" the cement out of the side ports, upward around shoe and casing, the odds are in your favor for a good cement job.
Look on page 176 of the 1936 Composite Catalog for details of this modern "Whirler Float Shoe", or write to Baker Oil Tools, Inc., at Huntington Park, California; Houston, Texas; or Tulsa, Oklahoma, for specifications, prices and recommendations.
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Removes
THESE QUESTIONS
FROM YOUR CASING CEMENTING OPERATIONS

MACHINERY and EQUIPMENT

New Design for Round Case Indicating Flowmeters

AMERICAN Meter Company has announced a new indicating flowmeter case of advanced design, simplicity, and attractive appearance.

This type of installation to indicate the rate of flow of air, gas, oil, steam, or water through a line in which an orifice is installed, is today in considerable demand, it is stated. It consists of a modified U gauge in which mercury is used as a liquid seal, and a sturdy and attractive case to enclose the pointer and dial.

A steel float that rests in the mercury in one of the columns is raised

Segmental Dial

Round Dial

by the rise of the mercury. The float is attached by a lever to a horizontal bearing shaft that extends through an adjustable lapped stainless steel stuffing box into the case.

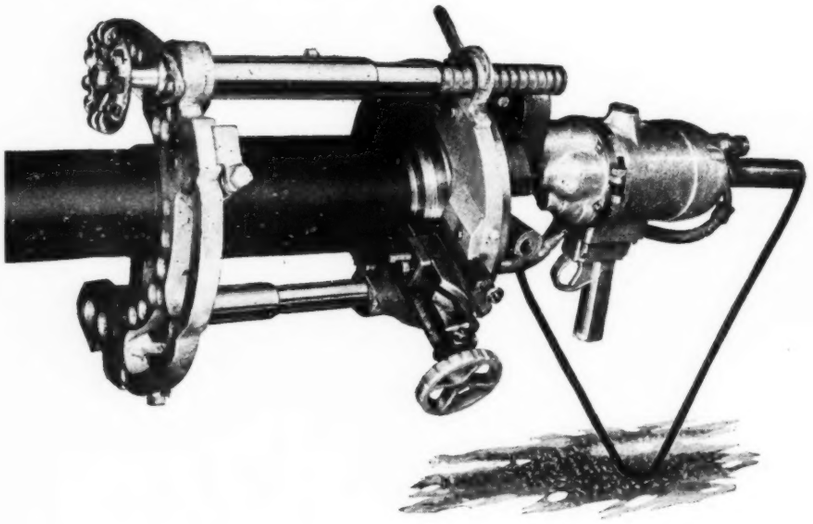
The differential ranges are: 0 to 100; 0 to 50; 0 to 20, and 0 to 10 in. of water, as specified by the customer. Special ranges are available.

Two types of cases can be obtained: the round dial and the segmental dial, as illustrated.

The construction of the differential gauge is forged steel throughout, the seal tube screwed and welded. All parts within the mercury chamber are stainless steel.

Complete engineering data and specifications may be obtained from American Meter Company's general office at 60 East 42nd Street, New York, New York, or from any of the company's factories or sales offices.

Machine Removes Leaks from Tool Joints on the Job

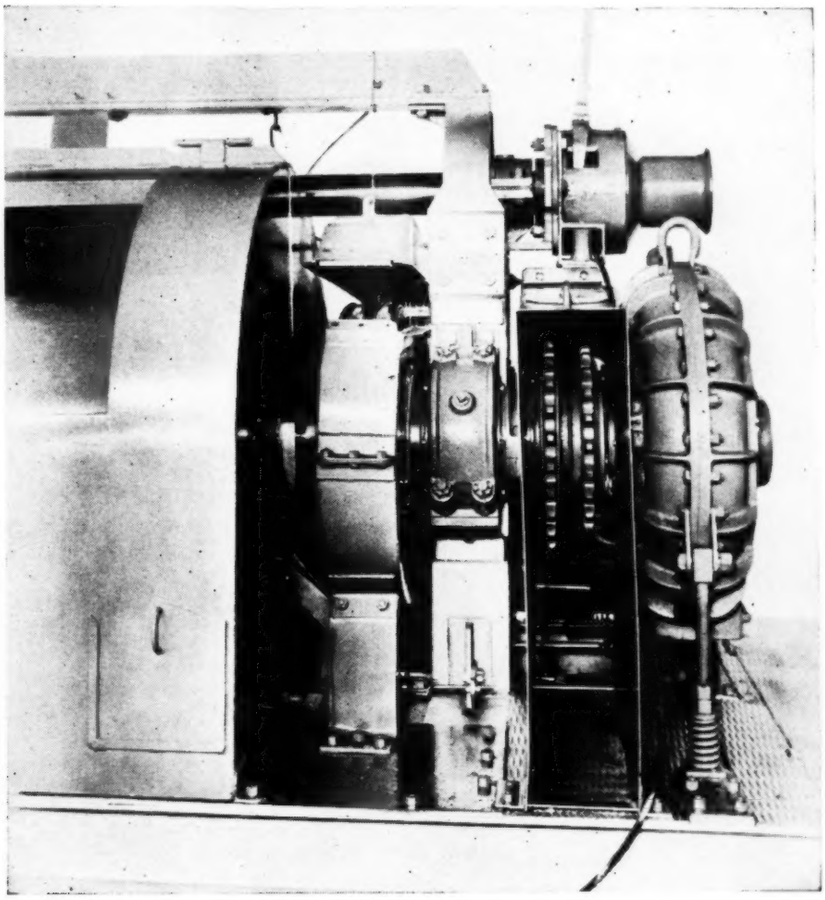


THE Portable Rotary Service Company announces a portable machine for repairing and facing tool joints on the lease. It is a concentrated, specialized portable facing unit. The milling machine works from a gauge or templet from which the cutting tool is set at an accurate predetermined distance, assuring gauge accuracy, the manufacturers state. The finest gauges obtainable for every size tool joint are kept on hand for instant use.

Among the features of the apparatus as listed by the makers are: 1. Makes tool joints standard and interchangeable by taking the slack out of them. 2. Makes accurate, efficient tool joints out of those that would otherwise be thrown away, because of lack of time and expense of taking to shop for reworking. 3. Reduces to minimum tool joints backing off with attendant costly delays and expensive fishing jobs. 4. Takes leaks out, thus minimizing the washing down of plaster of the wall of hole with consequent caving-in and sticking of drill pipe, resulting in expensive, long-drawn-out fishing jobs. 5. A good square seat is made on the bottom end of box for the elevators, a safety feature that minimizes accidents from pipe slipping through elevators. 6. Taking out leaks speeds up drilling, for leaking pipe reduces the fluid pressure at the drilling bit, resulting in cuttings not being carried away fast enough and the bit balling up.

Licensed operators serving the trade are: Merritt Tool Company, Kilgore, Texas, for East and South Texas and Louisiana; Holder-Jewell Company, Duncan and Ada, Oklahoma, for Oklahoma and Kansas; M. O. Johnston, 3117 San Fernando Road, Los Angeles, California, for territory west of the Rockies, also licensed to manufacture and sell for foreign use only. For further information refer to Portable Rotary Service Company, Inc., Box 516, Greggton, Texas.

"Big Giant" Drawworks of International Derrick and Equipment Company



THE International Derrick and Equipment Company announces the introduction of its "Big Giant" drawworks, designed for deep drilling, and complete in every respect. The unit weights 34,000 lb. net, has an overall height of eight ft., an overall width of eight ft., and an overall length of 18½ feet. Power is supplied by a 14 by 14 twin engine, equipped with a 22-tooth sprocket, and having a rated speed of 250 revolutions per minute. It has three speeds with a line speed of from 600 to 2300 ft. per minute. The drum is 60 in. in diameter, the drum spool 36 in. in diameter at the bottom of the grooves, and the drum length of spooling space is 36 inches. For a 1-in. wire line the capacity of the drum is 5430 ft., for a 1⅛-in. line 4290 ft., and for a 1¼-in. line 3460 feet.

A double-strand chain, with a minimum ultimate strength of 250,000 lb., is employed. Double cut-tooth sprockets are provided for the three drive speeds and the engine drive. The drum and line shafts are manufactured of chrome-nickel steel forgings, the shafts operating in heavy-duty roller bearings. The drum shaft is designed to accommodate a Hydromatic brake and a double roller-bearing rotary idler sprocket. The cathead shaft is made of carbon steel.

Chain drives for the drums are enclosed in oil-tight and dust-proof metal casings, or guards, and packing rings are placed around the sprocket hubs to prevent oil leakage and to seal the casings against the entrance of water, dust, and other foreign matter.

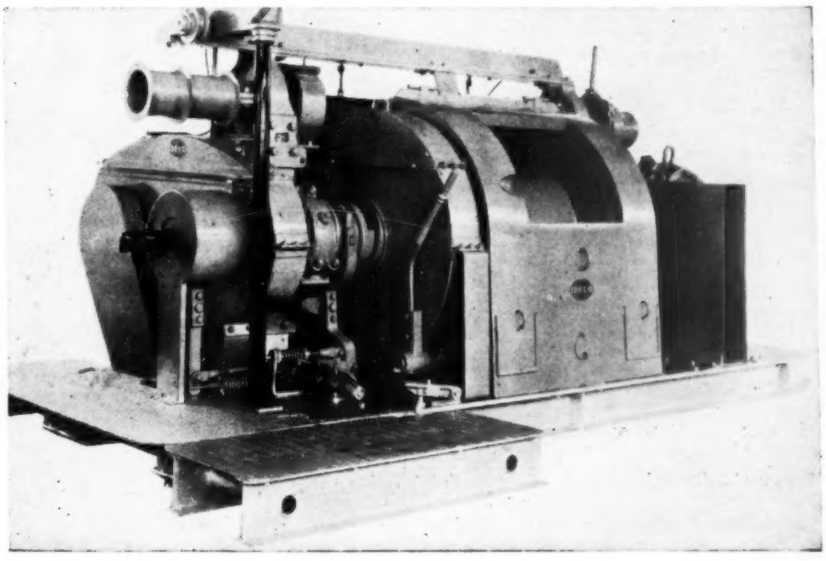
Brake flanges are constructed of forged alloy steel. They are water-cooled and are mounted on a chrome-nickel steel spider. Brake bands are of high-grade spring steel, rolled accurately to fit the flanges, being held free of the latter by springs.

On the driller's side of the drawworks is placed a chrome-nickel steel double cathead. On the opposite side is an automatic cathead. A special cathead shaft makes the catheads readily accessible to the driller.

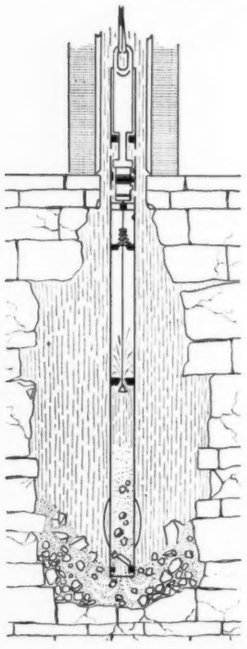
Clutches are entirely of chrome-nickel steel. For low and second speeds spiral clutches are used. Square jaw clutches are used in all other positions.

A compound floor-type brake and equalizer with 47 to 1 lever reduction is provided, giving a powerful and sensitive brake. Brake lining is of the woven block type.

Further information on the "Big Giant" drawworks can be obtained from the International Derrick and Equipment Company, at Columbus, Ohio, or Beaumont, Texas.



"Watch Your Shootin', Stranger"



Producers the world over have found The Cavins Automatic Hydraulic Suction Bailer to be the fastest, safest, and most economical tool for any kind of clean-out work. Here is an excellent example of one class of service in which it excels.

The illustration above shows the CAVINS in the act of taking on a load of shattered formation after the well has been shot. For recovering pieces of lime that are too large to enter the regular shoe as shown above, a Cavins junk basket is subbed to the bottom of the tool.

The Cavins can always be depended upon to do a first class clean-out job in record time, eliminating unnecessary production loss and expense. Send for Bulletin No. 36, giving complete information about Cavins equipment and service for any kind of clean-out or fishing job.

THE CAVINS COMPANY

2853 Cherry Avenue—Phone 414-14
LONG BEACH, CALIFORNIA
Cable Address: "Cavins, Long Beach"
Foreign Representative: R. J. Eiche

Bakersfield, California
Taft, California
Goleta, California
Santa Paula, California
Houston, Texas
Kilgore, Texas
Pampa, Texas
Oklahoma City, Oklahoma
Wichita, Kansas
Lyons, Kansas

Gaso Pumping Unit

THE Gaso Pump and Burner Manufacturing Company, of Tulsa, Oklahoma, specialists in oil industry pumps, have announced and are ready to make deliveries on the new pumping unit shown herewith, which can be supplied mounted either on skids or sturdy pneumatic-tired trailer, and with either internal combustion engine or electric motor drive. Drive is direct through a special flexible coupling.

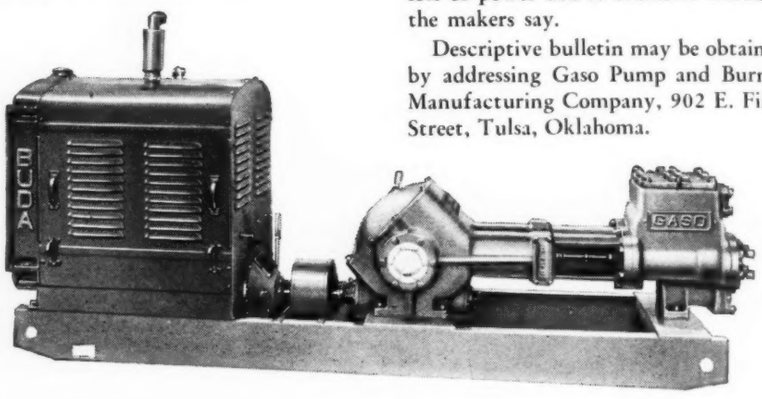
The unit is ideally suited for general service such as water lines, oil gathering systems, booster station service, or pick-up service, the manufacturers state. It is light in weight, yet of extra-sturdy construction to assure users long, trouble-free service in the field, it is pointed out.

The pump is a duplex piston, worm-driven, enclosed-type power pump. Ring gear is of alloy-nickel bronze and is mounted at the center of an alloy-steel crankshaft. Worm is of chrome-nickel steel, hardened and ground. These driving parts operate in oil bath in the enclosed crankcase and are mounted on Timken tapered roller bearings that are sealed off from the crankcase.

Pistons have cast-iron bodies and are regularly supplied with cast-iron snap piston rings, but any type piston ring may be specified. Figure 2244 has interchangeable liner type fluid end. Figure 2245 has inserted brass tube liner. But these pumps can be supplied with special alloy steel or bronze liners for specific services. Valves may be specified of Durabla stainless steel or of monel metal with bronze seats.

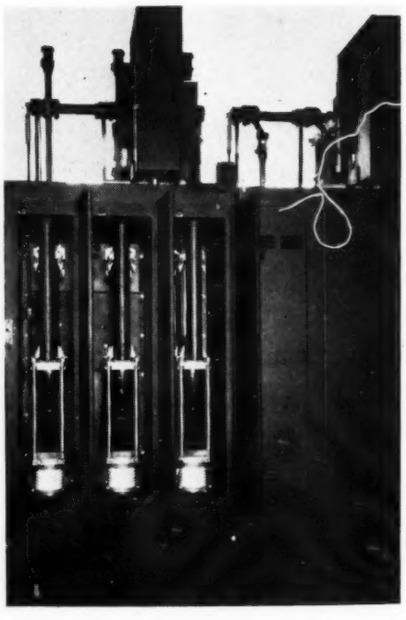
A valuable feature of design is the large fluid passages and valve openings, which permit proper filling at highest piston speeds without undue shock or loss of power due to excessive friction, the makers say.

Descriptive bulletin may be obtained by addressing Gaso Pump and Burner Manufacturing Company, 902 E. First Street, Tulsa, Oklahoma.



Steel Cubicles For Oil Circuit Breakers

NEW steel cubicles for Type FH oil circuit breakers, to replace masonry cells and bus structures for such breakers, have been announced by the General Electric Company, Schenectady, New York. The cubicles possess all the advantages of masonry structures and in addition are easy to install, the makers state. They have a high salvage value, should the location of the equipment be changed. A minimum of field construction work is necessary, since the cubicles are shipped completely assembled, ready for installation. Mechanical and electrical interlock features are available in the design as the application demands. The cubicles incorporate maximum accessibility consistent with safety, it is stated.

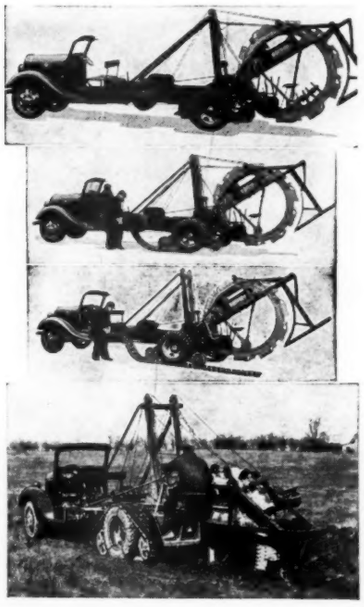


Rods for Light Gauge Welding

"THINWELD," a specially coated electrode for arc-welding light gauge sheet metal, is now offered in 1/16 in., 3/32 in., and ⅛ in. sizes by The Hobart Brothers Company, Troy, Ohio. They report that it is in great demand since the introduction of their new 75 and 100 amp. "Simplified" arc-welding machines. The manufacturers say that some operators have successfully arc-welded metal as light as 24 and even 26 gauge with the new Hobart models and "Thinweld."

Buckeye Model 16 Utility Ditcher

THE Model 16 Utility Ditcher, built by the Buckeye Traction Ditcher Company, of Findlay, Ohio, has a wide range of service in small trench digging. It is used in gas and



oil line service, gathering line, general farm and tile ditching, or any work requiring small trench.

Mounted on Ford, Chevrolet, or other standard truck chassis, the ditcher can be moved rapidly from one location to another at regular road speeds. The truck motor supplies the power for the ditching mechanism through a special transmission. The motor is supplied with an oversize radiator for better cooling facilities.

Buckeye "Alligator" crawlers are applied direct to the dual rear wheels. Small detachable idler wheels in front and behind the rear wheels increase the crawler area, thereby enabling the ditcher to work on soft ground. These "Alligator" traction wheels may be put on or taken off and conveniently stowed away in approximately twenty minutes.

The Model 16 Utility Ditcher is built with the same rugged construction and engineering so well known on the large Buckeye pipe line ditchers.

With a maximum cutting depth of four ft. six in., and cutting width from 9¼ in. to 16½ in., and with digging speeds from 1.45 ft. to 15.85 ft. per minute, these machines have a definite place in the type of work requiring small trench, the manufacturers point out.

Complete information regarding this time and labor-saving ditcher can be obtained from The Buckeye Traction Ditcher Company, Findlay, Ohio.

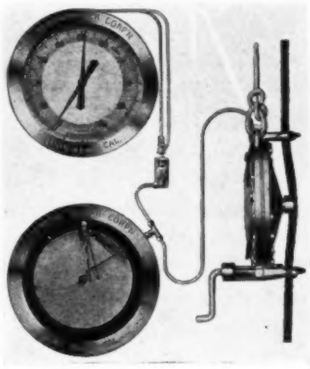
DATE June 27-36

Pipe twisted off at 3:30 this morning.

THERE IT IS IN BLACK AND WHITE...BUT WHAT CAUSED IT?

It could be any of several things, but more often than not it was *"Too much weight on the Bit."*

A recorder on the weight indicator will tell you positively and enable you to avoid future twist-offs when other wells are in the same formation.



Automatically recorded weight is full value weight and is only possible with a *Martin-Decker Full Range Temperature Compensated Weight Indicator.*

THE WEIGHT INDICATOR

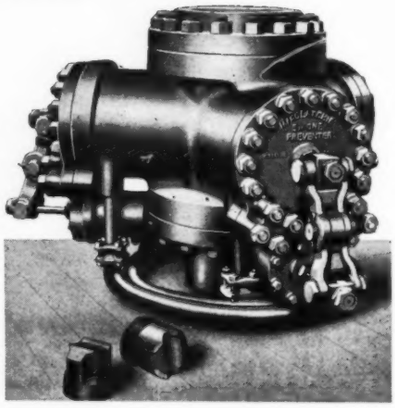
MARTIN DECKER CORP.

LONG BEACH CALIFORNIA

San Joaquin Valley: A. F. McQUISTON, Bakersfield, California
Mid-Continent Distributor: REED ROLLER BIT COMPANY, Houston, Texas

MacClatchie Introduces New Blowout Preventer

MacCLATCHIE Manufacturing Company, Compton, California, has recently brought out their "5 in 1" blowout preventer that, according to the makers, packs off any portion of the drill string happening to be suspended in it regardless of size or shape. According to the manufacturer it accomplishes this with lightning like speed—approximately 55 seconds. As no sand or dirt can enter to impair its proper functioning it always packs off with a positive certainty, it is stated. This preventer is



constructed to withstand the pressures of present day drilling, being tested to hold 4000 lb. cold water pressure.

It packs off the drill pipe and square kelly with the same set of packers. Without any change in the packing the MacClatchie "5 in 1" blowout preventer will pack off any part of the string, such as drill pipe, kelly, drill collars, tool joint, or pipe collar—providing five preventers in one and thereby greatly reducing the investment in equipment and cellar space, the makers claim.

It is constructed with three cylinders, having a heavy rubber packer operated by hydraulic pressure in each cylinder. These packers are made of 5000 lb. tensile strength rubber and are three in. thick, providing a large safety factor in handling the highest pressures. The rubbers are confined in steel plates to restrict their expansion to the desired area. An illustrated bulletin may be had by writing the manufacturer.

Taylor Motosteel Even-action Valves

THE completely redesigned line of Taylor Motosteel diaphragm valve motors employs an all-steel welded construction. This new construction is light in weight, strong, and has great resistance to shock and strains, the manufacturers state. Other innovations listed by the makers are:

A smooth, quick-acting, and powerful valve motor is obtained by: A larger molded diaphragm of advanced design. Formed impressions in the top plate that provide freer access of air pressure to the diaphragm in starting, thus insuring greater effective initial force. A longer and larger diameter spring gives greater initial compression, less hysteresis, and more accurate response.

A ball-bearing, roller-bearing stem guide assures a free rolling action throughout the entire stroke.

Spring and spring adjusting nut, as well as other moving parts, are fully enclosed, yet are readily accessible for adjustment or maintenance by removing the side plates.

Valve position indicator readily establishes the valve opening. Write to Taylor Instrument Companies, Rochester, N. Y., for further details.

Because . . .

COOK'S Piston Rings

reduce cylinder wear . . .

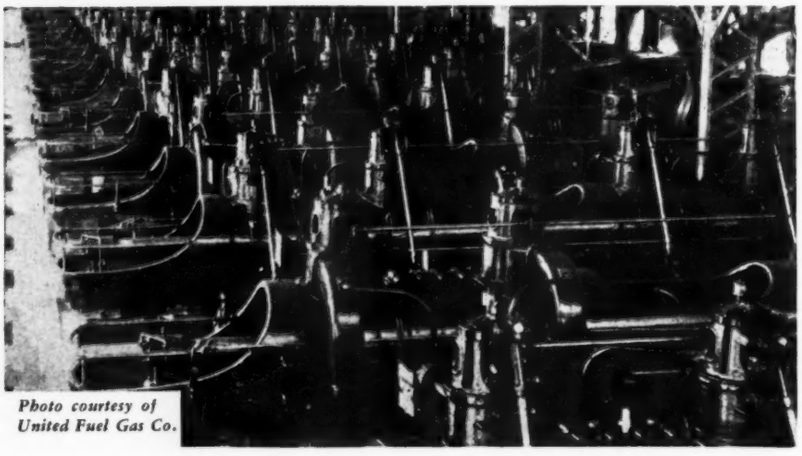


Photo courtesy of United Fuel Gas Co.

. . . they* predominate *in the

NATURAL GAS INDUSTRY

The selection of COOK'S GRAPHITIC IRON Piston Rings by a great majority of the prominent operators of Natural Gas pumping engines, adds further evidence of the widespread recognition of COOK'S Rings' superiority. They predominate because of the operating economies they effect — reduced cylinder wear — added years of engine life — fewer shutdowns for repairs. You, too, can obtain these economies by specifying COOK'S Rings on your next order.

COOK'S GRAPHITIC IRON PISTON RINGS

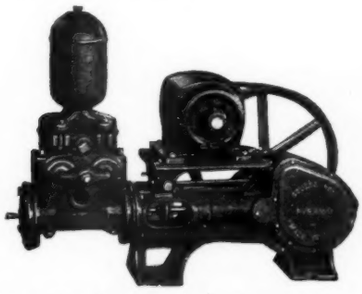
C. LEE COOK MANUFACTURING CO.
Incorporated
LOUISVILLE, KY.

New York Cleveland Los Angeles Baltimore Chicago Tulsa New Orleans San Francisco

Goulds Power Pumps

GOULDS Pumps, Inc., Seneca Falls, New York, manufacture a line of power pumps suited for general pumping services in the oil field. These pumps, known as the Figure 1813 "New Pyramid" pumps, are of the single-cylinder, horizontal, double-acting type, built in four sizes, with capacities of from 420 to 3500 gal. per hour. The power end is a substantial one-piece casting that forms the base of the pump, houses the gears, crosshead and guides, forms the oil reservoir, and supports the fluid end.

All working parts of the pump are continuously and automatically supplied with oil, the patented oil circu-



lator distributing the oil to all bearings, pins and guides. A concave water deflector prevents any gland leakage from entering the oil reservoir, the manufacturers state.

The cylinder is a one-piece casting fitted with a brass cylinder lining, two separate removable cylinder heads, large rubber valve discs on bronze grid seats situated above the cylinder to assure priming and prevent air binding. Suction and discharge valves are easily reached without disturbing piping.

The piston rod is of stainless steel. Piston is packed with two Goulds "Tiger" brand crimped leathers.

Adjustable motor mounting with sliding type motor rails permits easy mounting of any motor without drilling or other machine work.

Conveniently placed priming and drain plugs make this pump easy to prime or drain without loosening air chamber, cylinder heads, or other part of the pump, the makers state.

A large air chamber cushions the water flow. Removal of this chamber exposes the two studs, each holding a pair of suction and discharge valves.

Machine Tests Stability of Greases

DESIGNED and developed by the Bearing Engineers' Committee, a new device is now offered to manufacturers and extensive users of greases and bearings by the Taft-Peirce Manufacturing Company, Woonsocket, R. I., as a positive means of determining the mechanical stability of heavy lubricants. The machine works a definite amount of grease in a moderate sized bearing running at a medium speed, at various test temperatures, and while it does not indicate the lubricating value of the grease, it does give definite information on starting and running torque, oil separation, change in structure and consistency, channeling, leakage past bearing seals, aeration and the consequent increase in grease volume, the manufacturers state.

The unit is equipped with a constant-speed, 3450 r.p.m. motor, on the spindle-extension of which is mounted a plate-shielded, size 204 SAE bearing. The bearing is mounted in a grease cup that is free to turn, and the grease is brought to a predetermined temperature that is recorded by a dial thermometer. Accessories consist of a grease-measuring cup, melting point apparatus, and the BEC Penetrometer. The last item is also available from the Taft-Peirce Manufacturing Company at Woonsocket, Massachusetts, as are bulletins describing the equipment.

36 Pump Repair Jobs *Eliminated* with a FLUID PACKED PUMP

. . . it pumped continuously with **NO DOWN TIME** *for repairs for 3 years in a well where other pumps lasted only 30 days . . .*

How would you like to save the cost of 36 pulling jobs, the expense of repairing a pump 36 times — to say nothing of tanking the oil that you *didn't* get while your well was shut down? It must be a lot of money, for the operator* who gave us this report was mighty happy about the 3 year performance record of his Fluid Packed Pump.

Here are the reasons why this Fluid Packed Pump stayed on the job for 36 months in a well where abrasive conditions were so bad that other pumps failed in 30 days: The liberal annular channels between the telescoping tubes permit sand to pass without freezing and with minimum abrasive effect. There are no cups to be replaced, and the fluid being pumped is in itself the packing — it can never "wear-out."

** Name on request*

See the Fluid Packed Pump section in your 1936 Composite Catalog—or write our nearest office for complete information.

FLUID PACKED PUMP CO.
BOX 64 • LOS NIETOS, CALIFORNIA • U.S.A.

Mid-Continent and Texas Distribution

FLUID PACKED PUMP CO.—MID-CONTINENT
2 S. E. 29th ST., OKLAHOMA CITY, OKLAHOMA

Gulf Coast Headquarters: **409 Velasco St., Houston, Texas**

A MODERN PUMP FOR MODERN CONDITIONS

Protected by Patents No. 1545474, 1545475, 1549175, 1621046; others pending.

Drill Collars of the National Supply Company

IT is a well known fact that in boring drill collars by regular methods allowance has to be made for deflection due to gravity. At best, this is a matter of the machine operator's judgment and experience. In order to make the boring of accurate circulation holes certain and automatic, The National Supply Company has built special machines that bore simultaneously from both ends and revolve the drills and drill collar in opposite directions. This imparts a natural inclination for the drills to seek and follow the true geometric axis of the collar and results in circulation holes more accurate and uniform than can be obtained by any other known method, the manufacturers state.

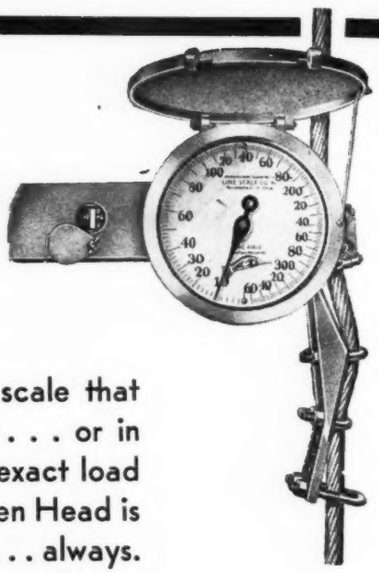
The description "True Center Bore" has been given to Ideal Rotary Drill Collars because circulation holes are centered on the true axis of the collar. This results in uniform wall thickness that gives increased strength and balance in rotation at high speeds. Circulation is unhindered and there is a minimum of opportunity for abrasion from sand in the fluid, the makers say.

Ideal "True Center Bore" Drill Collars are forged from selected alloy and carbon steels and normalized in one full length heat following the forging operation. Also they are available with heat treated ends, quenched and drawn for four feet on each end after normalizing. In addition they may be supplied fully heat treated, normalized, quenched and drawn in three separate full length heats. Normalizing removes forging strains and heat treatment improves the physical properties of the steel, adding hardness, toughness, and strength. National regular shop inspection requires that a 10 ft. test bar only ⅛ in. larger than the nominal bore pass freely through every collar.

"I Can't Tell a Lie"

. . . . Says

GREEN HEAD LINE SCALE



You wouldn't want a line scale that couldn't tell you the truth . . . or in other words, give you the exact load on the line at all times. Green Head is accurate and dependable . . . always.

Rugged Construction, easy to read and easy to install. No fluid to leak; no parts to get out of order. Buy a Green Head and be safe!

Distributed by

GREEN HEAD

BIT AND SUPPLY CO.

OKLAHOMA CITY, OKLA.

Scott, Louisiana Houston, Texas Odessa, Texas

TAG Colorimeter Stand and Daylight Illuminator

A NEW colorimeter stand and daylight illuminator is announced by C. J. Tagliabue Manufacturing Company. This new adjustable stand is used to support and illuminate either the TAG-Saybolt Chromometer (as shown in the illustration), or the TAG-Robinson Colorimeter. The light source is the standard TAG-Macbeth Daylight Lamp and the diffusion screen placed between the lamp and the instrument is a flashed opal glass. Both lamp and screen meet the latest A. S. T. M. specifications for this equipment.

A large oil company suggested this arrangement and found that a much more effective illumination could be obtained if the rays of light from the daylight lamp, instead of being reflected, pass directly up through the tubes of the chromometer or the colorimeter. Illuminator is designed so that all light is excluded except that coming from the lamp.

Bulletin No. 1143 describing this new device will be sent free upon request by the manufacturer, C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, New York.

Trade Personals

T. N. ST. HILL, vice-president of the Petroleum Rectifying Company of California, left Los Angeles by plane recently to confer with refinery executives at Wichita, Kansas, relative to the Petreco Electromatic Desalting Process for removing salts from refinery charging stocks. He returned to Los Angeles a few days later.

L. W. GROTHAUS has been elected vice-president of the Allis-Chalmers Manufacturing Company of Milwaukee, Wisconsin. He has been with the company for 32 years and since 1933 has been assistant to the president.

J. C. BLOOMFIELD has joined the shovel, dragline, crane division of Link-Belt Company, Chicago, Illinois. **L. P. SPILLAN** has been appointed shovel and crane division sales manager in charge of sales to contractors, with full supervision over all sales agents and distributors. **N. A. WESTON** has been placed in charge of shovel division industrial sales in the Chicago territory. **G. H. OLSON** is the company's shovel and crane division general manager.

BENJAMIN C. BUGBEE, industrialist and engineer, associated with Cahill and Company, consulting engineers, of Milwaukee, and **DR. M. A. HADDOCK** of Waukesha, have been elected directors of the Waukesha Motor Company to fill the vacancies created by the deaths of **H. L. HORNING** and **A. S. CRONK.**

A. E. AVERS, who has been western representative for the Young Engine Corporation for the last three years, has been transferred to Tulsa.

EDWARD A. LIVINGSTONE has been appointed manager of alloy tube sales for The Babcock and Wilcox Tube Company, Beaver Falls, Pennsylvania. Prior to his appointment he was engaged in the development and introduction of special B & W high-temperature, corrosion-resistant alloys to the oil industry throughout the United States.

M. E. NICKLIN has been made export manager by the Waukesha Motor Company, and early this month sailed for an extended trip through southern and central Europe. He will visit Albania, Greece, Austria, France, Belgium, Holland, Spain, Germany, Portugal, and England before returning.

JULIAN C. GONZALEZ has been elected secretary of the Ethyl Gasoline Corporation to succeed the late Arthur E. Mittnacht.

WILLIAM H. PHILLIPS, recently with Harry Pratt Company of Chicago, has joined the Worthington Pump and Machinery Corporation as Power Plant Specialist with headquarters at the Corporation's Chicago office.

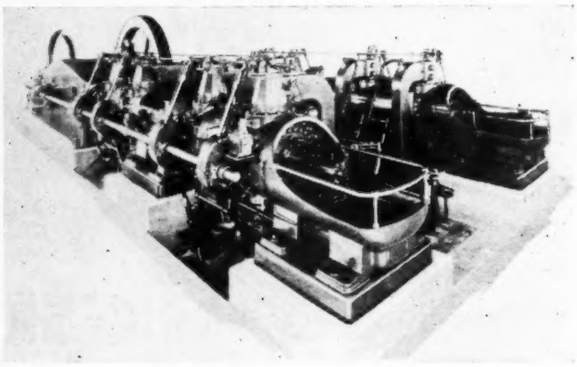
THEODORE B. WIRTH has resigned as field engineer with the A. M. Byers Company, Houston Division, and accepted a position as promotional engineer for Higgins Industries, Inc., New Orleans.

SURE IT'S TOUGH
Grizzly Powerflex Rotary Hose has what it takes to withstand the high pressures and heavy pounding of deep well drilling.
Its remarkable performance records in some of the deepest and toughest wells in the world attests to its rugged construction, extreme flexibility and super strength. Grizzly Powerflex will give you the maximum in Safety —Service and Satisfaction.
A Bear for Wear
GRIZZLY POWERFLEX
FLEXIBLE
POWERFUL
A Bear for Wear
E. M. SMITH COMPANY
600-650 South Clarence Street, Los Angeles, California, U.S.A.
Sold in the Mid-Continent and Gulf Coast by: Continental Supply Company, and T. T. Word Supply Company, Inc., Houston, Texas—In All Their Stores
Export Office: Continental Emsco Company 30 Rockefeller Plaza New York City

Big Compressors for Large Gasoline Plant

What is said to be one of the world's largest gasoline plants, is being erected by the Warren Petroleum Company and the United Gas Public Service Company in the Rodessa field, Caddo Parish, Louisiana.

Eight large Cooper-Bessemer compressor units will be installed, to compress the United Gas Public Service Company's wet gas, remove the gasoline, and then boost the dry gas to 450 lb. and send it into the utility's line. The compressor units are standard "Type 22's" each rated 1000 horsepower. They are four-cycle, twin-tandem, gas-engine-driven machines.



Eight Cooper-Bessemer 1000-hp. compressor units of this type have been ordered for one of the world's largest gasoline plants

A feature of this project, apart from its large size, is the sending of dry gas direct to market instead of recirculating it or using it for field operations.

P. R. King Special Representative for Taubman Supply

P. R. King was appointed special representative of the Taubman Supply Corporation, Tulsa, Oklahoma, effective July 1st. King is well known throughout the oil and gas industry, for six and one-half years having been representative of the Republic Supply Company covering Kansas and Oklahoma territory. During the year just prior to his coming with the Taubman organization, he was division sales manager for the Portable Rig Company of Houston, Texas, with his headquarters in Tulsa, Oklahoma.

P. R. KING

Nearly all his life has been spent in the oil fields, his boyhood having been spent on a lease near Ochelata, Oklahoma. After graduating from high school, he attended the University of Missouri, coming back to the oil fields when he finished college, and has since been engaged in the supply business.

S. M. Jones Co. to Modernize Plant

The S. M. Jones Company, oil well supply manufacturer in Toledo, Ohio, has announced the awarding of contracts totaling $150,000 for an extensive plant modernization program. Plans largely call for the installation of new equipment, with some additional building.

The program was made necessary to replace obsolete equipment and to modernize the plant, according to Percy C. Jones, president of the firm.

THE STANDARD OF WATER COOLING ENGINEERING

In 1929 the first Fluor Aerator Type Cooling Tower was erected. Its successful operation achieved a new goal in efficient and economical cooling. The succeeding short space of time has seen the universal acceptance of this tower as the standard of water cooling engineering.

Proof of its superiority rests upon its practical utility for industries' cooling requirements, superiority attested to by increased numbers of new and old customers the world over.

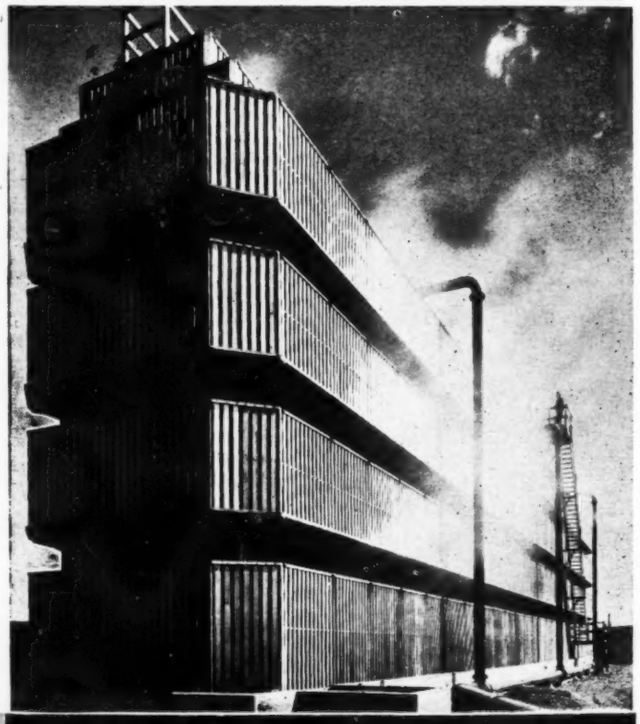
Well established is the fact that today more Aerator Type Towers are being purchased than all other types of atmospheric towers combined.

A new Bulletin, T236, describes Aerator Type Towers in detail. Write for your copy.

THE FLUOR CORPORATION, LTD.

909 EAST 59TH STREET, LOS ANGELES, CALIF.

30 Church St. New York City, N. Y.
909 McCormick Bldg. Chicago, Illinois
1406 Esperson Bldg. Houston, Texas
703 Fairfax Bldg. Kansas City, Mo.
719 McBirney Bldg. Tulsa, Oklahoma



BE SURE WITH FLUOR

FLUOR AERATOR TYPE COOLING TOWERS

M. E. Leeds Receives Two Signal Honors

M. E. LEEDS

Morris E. Leeds, president of Leeds & Northrup Company, Philadelphia, Pennsylvania, recently received two signal honors. He was awarded the Henry Laurence Gantt Gold Medal given annually by the Institute of Management "for distinguished achievement in industrial management as a service to the community," and the Polytechnic Institute of Brooklyn made him a Doctor of Engineering "in recognition of great service to society."

Slide Rule for Use in Pipe Line Problems

In the October, 1935, issue of *The Petroleum Engineer* an article was published entitled: "Calculations for and Methods of Design of Slide Rule for Use in Oil Pipeline Problems." The authors were L. V. W. Clark, R. Fallah, and A. W. Nash, all of the Department of Oil Engineering and Refining of the University of Birmingham, England. As a result of the article Mr. Clark writes that he has had a number of inquiries from engineers as to where the rule can be purchased. Recently Mr. Clark arranged with a firm to manufacture the rules in event there were a sufficient number interested. Inasmuch as he does not wish to make any profit on the rules himself he is desirous of knowing before proceeding further how many would be interested in purchasing them at actual cost. Write Mr. L. V. W. Clark, Department of Oil Engineering and Refining, University of Birmingham, Birmingham, England.

W. W. Bond Visits Mid-Continent and Gulf Coast

W. W. Bond, of the Indianapolis factory of Link-Belt Company, spent the last two weeks of June in the Mid-Continent and Gulf Coast territory. He was accompanied from Dallas to Houston and other coastal points by G. N. Howson, manager of the Dallas branch of the industrial division of the company.

A Daughter for Mr. and Mrs. Homer Thornhill

A daughter, Betty Jane, was born to Mr. and Mrs. Homer E. Thornhill of Houston, Texas, June 24th. This gives the president of the Thornhill-Craver Company a running mate for his husky three-year-old son.

Diesel Engineer Available

Diesel maintenance and operating engineer, 17 years' experience, would like to make a connection with a progressive pipe line or oil company. Does not object to a foreign assignment. Now employed but wishes to make change. Write Box 717, *The Petroleum Engineer,* Dallas, Texas.

Larger Plant for JENSEN JACKS

Experienced producers are demanding JENSEN Straight-Lift PUMPING UNITS and Rod Line JACKS in ever increasing volume. More than three thousand square feet of floor space has been added to the factory facilities for turning out JENSEN Pumping Equipment.

Write us a letter or shoot us a wire for the facts and figures about the economy and efficiency of JENSEN equipment. It pays to keep up with progress!

JENSEN BROTHERS MANUFACTURING COMPANY
Coffeyville, Kansas, U. S. A.

JENSEN JACKS

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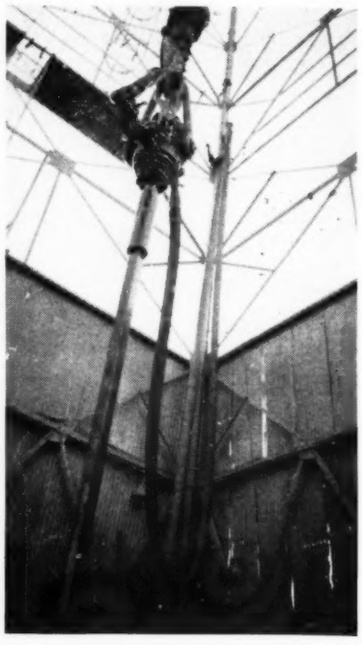
Rotary Hose Establishes Endurance Record

The accompanying illustration shows a section of rotary hose that not only participated in a record breaking drilling operation but is well on its way to establish an endurance record for itself.



This 45-ft. section of 2½-in. Goodrich Hipress rotary hose, wire and tape wrapped, was first used to complete a well, Berry No. 1 (California), carrying the drilling from 4500 ft. to completion at 11,377 ft., which broke the record at that time for the world's deepest producing oil well. The hookups used in this operation were dual Gardner-Denver pumps developing an average drilling pressure of approximately 1200 lb., although occasionally the pressure went considerably higher.

Upon completion of this well the hose was sent to Beer No. 1 in the Belridge oil field where it was used to drill a second well to completion at a depth of approximately 3800 feet.

Still being in excellent condition and showing no signs of weakness, the hose was then moved to a third location in Sunshine Valley where, according to last reports, it is still in active service.

Wife of D. H. Barnwell Passes Away

Arvilla Barnwell, wife of D. H. Barnwell, manager of northern sales for Axelson Manufacturing Company, died in Los Angeles recently. Burial was from Wee Kirk O' The Heather, Glendale, California.

Mr. and Mrs. Barnwell resided at 309 "E" Street, Taft, California, where both were well-known. Barnwell has a widespread acquaintance throughout the California oil industry and his many friends will be sorry to hear of his loss.

Sperry-Sun Opens Branch at Santa Barbara, California

In order to better serve its clients on the West Coast the Sperry-Sun Well Surveying Company has opened a branch office at 316 West Anapamu Street, Santa Barbara, California. The branch formerly at 1237 K. Street, Bakersfield, has been discontinued, and to serve immediate needs of customers in the San Joaquin Valley arrangements have been made for the storing of H-K Clinographs and supplies with A. F. McQuiston, 3314 Chester Avenue, Bakersfield.

The company's main California district operating office is, as previously, at 549 East Bixby Road, Long Beach.

Book Reviews

The Handbook of Applied Mathematics (Second Edition). By Martin E. Jansson, civil engineer, and Herbert D. Harper, Murray Hill Vocational School, New York City. Published by D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York City. 900 pages. Price $6.00.

Practical mathematical methods that can be applied to any line of work are contained in this volume. The various sections of the manual include a review of all the mathematics that should be known to make every type of calculation; every trade is taken up and full explanations of practical methods plus easily worked formulas for applying these methods are given; technical subjects are discussed; and to complete the picture all types of business calculations and all basic branches of accounting are shown. Arranged in the same manner as a handbook of engineering, the book provides the same advantage in trade and business calculations that is gained in engineering computations by the use of a handbook.

* * *

Elements of Diesel Engineering. By Orville Adams, consulting Diesel engineer. Published by Norman W. Henley Publishing Company, 2 West 45th Street, New York City. 478 (6 x 9) pages; 284 illustrations. Price $4.00.

The purpose of this volume, written in simple language and copiously illustrated with numerous helpful graphic charts and lettered sectional and phantom drawings of all types of engines and their parts, is to instruct the beginner in the elements of the subject. Students of engineering will find the practical explanation and summaries of numerous basic factors of Diesel design and construction of great benefit. The volume is suitable for either home study or classroom use. Every basic fact necessary to a complete understanding of the elements of Diesel construction and operation appears to be explained, analyzed, and briefed for easy assimilation by readers of ordinary mechanical ability. The Questions and Answers for review at the end of each chapter will be found valuable for examination purposes.

* * *

Petroleum Refinery Engineering. By W. L. Nelson, consulting petroleum and chemical engineer, and professor of petroleum refining, University of Tulsa, Tulsa, Oklahoma. Published by McGraw-Hill Book Company, 330 West 42nd Street, New York City. 647 pages. Price $6.00.

In this volume the author, realizing that while there are many valuable reference books pertaining to petroleum refining, as yet there has been no adequate presentation of the fundamentals of engineering design and processing. Petroleum Refinery Engineering has been written with the hope that it will aid in clarifying the many detail questions that arise during plant operation, as well as encourage the refinery engineer to utilize the principles of chemical engineering more fully. Both refining processes and theories are discussed. The inclusion of considerable hand-book information and comprehensive references to refining literature are valuable features of the book.

Readers of *The Petroleum Engineer* are familiar with W. L. Nelson's "Elements of Applied Petroleum Refining" that have just finished running serially in this publication.

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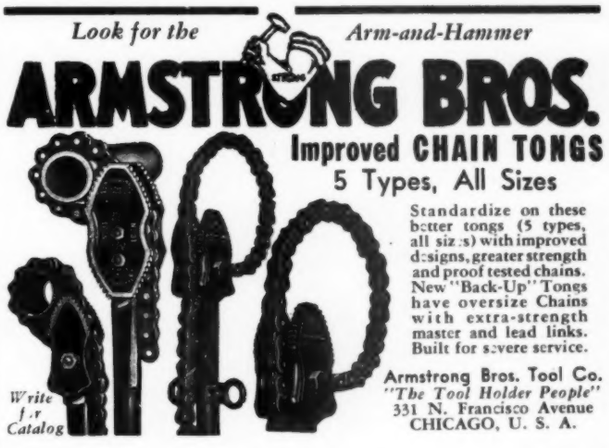
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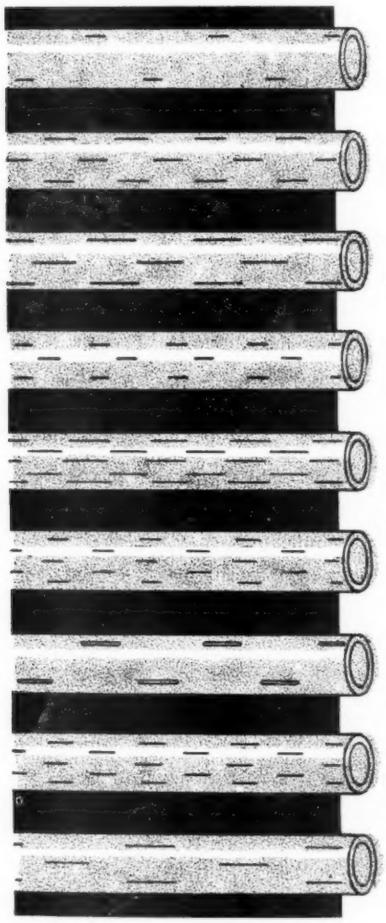

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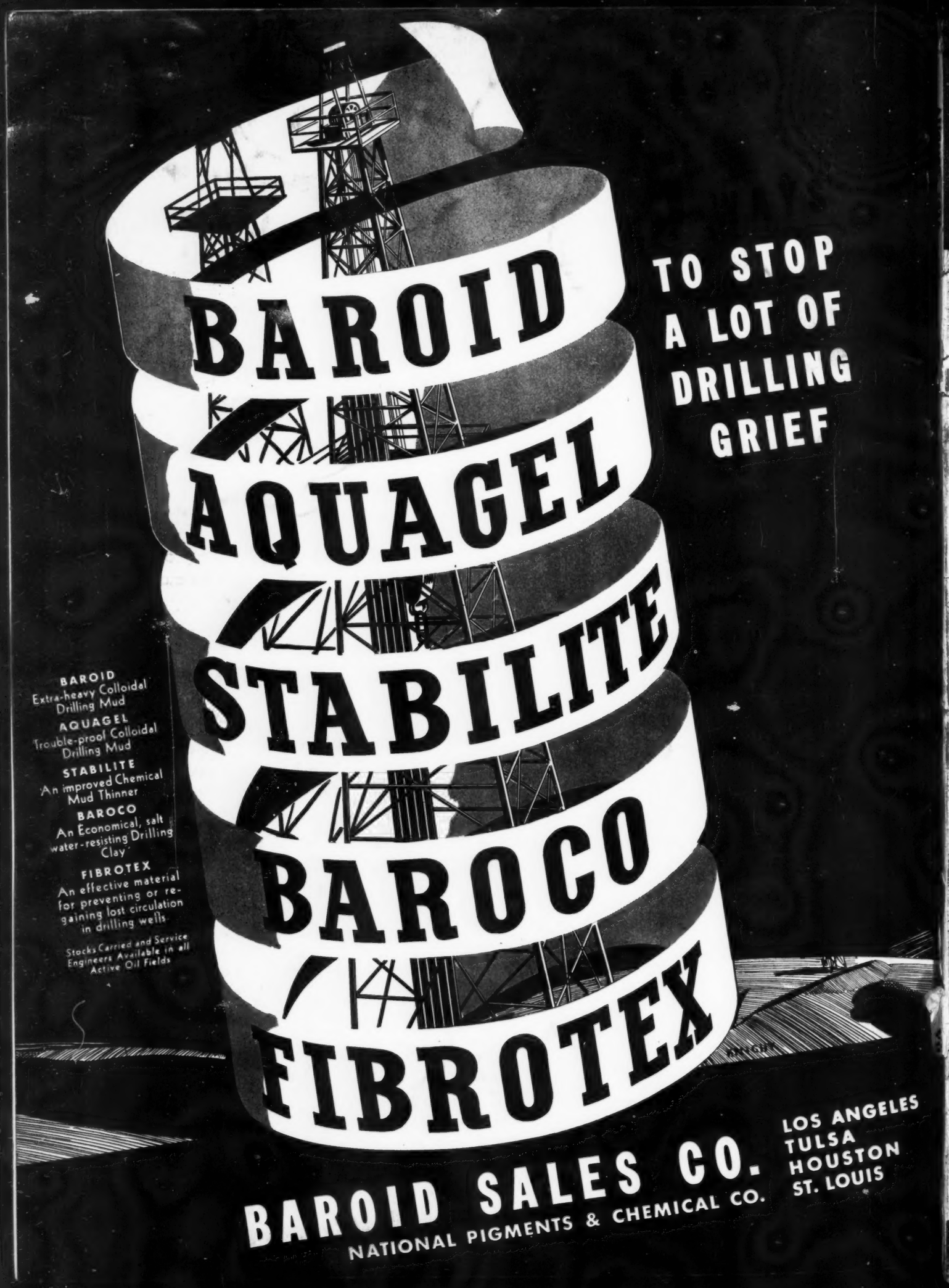
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